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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332)*

Forthcoming Events.

JUNE 4-7.

Institution of Gas Engineers:—Annual general meeting in London.

JUNE 5-15.

International Foundry Trades Exhibition, Royal Agricultural Hall, London, N.

JUNE 10-14.

International Foundry Congress:—26th Annual Convention of the Institute of British Foundrymen.

The Balfour Report—Concluded.

We have summarised the leading features of this Report for our readers less as a substitute for perusal of the Report itself than as an incentive to do so, in view of its obvious bearing on and application to problems now being faced by every business man.

The section dealt with last concludes with a consideration of statistics, including costs. One witness is quoted as saying that lack of knowledge of costs is due "to indifference, or more often to ignorance, of scientific methods of costing, which are generally looked upon as at best a necessary evil." A census of production and of wages every five years is urged in addition. It is stated that many manufacturers are not aware of income-tax reliefs which would be granted on expenditure on research, welfare, superannuation funds, and so on. With regard to the cost of social services, it is pointed out that the sense of security they give is often forgotten in comparison between English and other wage rates.

As to safeguarding, the Report urges that industries needing to be safeguarded should satisfy the authority concerned that they make adequate provision for research. So, in every aspect of the question, we come back to the things that we in these columns have repeatedly urged upon the consideration of manufacturers—costing, welfare, research, education, and so on. They cost money, but, as the Report says in the beginning, "if business efficiency is inseparably related to cost, so also the question of reducing costs must always be thought of in terms of business efficiency. Mere reduction of expenses, whether through cutting down salaries or wages, or lowering the quality of materials, or curtailing expenditure on research or on selling organisation, may be the very reverse of true economy. It is, in fact, a criterion of high business capacity to be able to distinguish unerringly between true and false methods of reducing costs." In conclusion, we quote a few other outstanding points.

Trade Associations.—". . . well-equipped trade associations are, we fear, only a minority."

Standardisation. — "The light castings industry has found it comparatively simple to reduce the types of baths to six, but has encountered difficulties in simplifying the sizes of pipes." "Some of the principal trades concerned have as yet shown far less responsive interest in the efforts made to promote standardisation than is reasonably to be expected from them on any just and far-sighted view of their own interests. Partly this want of interest is ascribed to the relative lack of technical training."

Education.—"The outstanding need at present is not so much for an extension or amendment of the facilities offered by the colleges and other institutions . . . as for a more intelligent appreciation on the part of the business community, both of the value of more highly trained men to business, and of the necessary conditions which define and limit their utility in any particular case."

Quoting a witness, the Report says: "We live to-day in a world infinitely more technical than it was 20 years ago, and the old-fashioned type of more or less self-made man, who had grown up as a practical man inside a factory and reached the position of works manager, is now definitely out of date. His continuance in this position is, in my opinion, largely responsible for the parlous condition of many of our industries, particularly engineering and textile." "The continual increase in size of the business unit necessarily involves an increased demand for men of greater calibre for purposes of the higher control; and without an adequate supply of such men the benefits of the larger unit will not be realised." Actual quotations on the subject of research have already been given.

So we leave this Report. We repeat that it is on the whole the work of business men who have had unique opportunities of seeing the evidence. It is non-political, for the committee was appointed by Mr. Ramsay MacDonald, it reports to Mr. Baldwin, and no one knows to whom will fall the task of giving effect to its recommendations, so far as any Government can do so. But we feel that the future of British trade, and hence of the British people, largely depends on our response in the matter, and that it lies almost wholly with ourselves.

Welcome!

It would be remiss if, as the leading organ of the foundry trades of Great Britain, we failed to take this opportunity of saying, on their behalf, how delighted the British community is of welcoming to its shores foundrymen of all nations. To the Americans we offer a special greeting, as they were our hosts in 1926. The warmth of the reception accorded to the British delegation is still remembered with gratitude by the participants. To the French, too, are British founders indebted, as on more than one occasion many of us have enjoyed their hospitality. Germany, also, has been our host during the run of the wonderful Düsseldorf exhibition, and on that occasion proved very charming hosts. Belgium and Spain, too, have assumed the rôle of host to the world's foundrymen, and each has succeeded in creating in the minds of their visitors an impression of cordiality and foundry enterprise. Guests from the Dominions are especially welcome, as the great distances separating us makes their visits much less frequent than we would desire. Finally, to the delegates from Holland, Czecho-Slovakia, Scandinavia, Poland and Russia we bid you welcome, and trust that the contacts you will make with your British hosts will be pleasurable and profitable.

XUM

Metallurgists' Congress in Germany.

A large attendance is promised at the forthcoming German meeting of the Institute of Metals, to be held in Düsseldorf on September 9-12. This will be not only the first meeting of the Institute to take place in Germany, but will also constitute the first gathering of metallurgists and engineers to be held in Germany since 1914. The Conference is being held by invitation of the Verein Deutscher Ingenieure and of the Deutsche Gesellschaft für Metallkunde. In addition to the presentation and discussion of Papers by members of many nationalities—nearly every country in Europe will be represented at the meeting—there will take place visits to works as well as gatherings of a social character. Though participation in the meeting will be limited to members of the Institute, non-members desirous of taking part can be elected—providing that their qualifications are satisfactory—in time to take part in all the proceedings at Düsseldorf, if their applications are received not later than July 4 by the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Wilkinson Cupola.

To the Editor of The Foundry Trade Journal.

Sir,—The reference to the Wilkinson cupola in the first part of Mr. A. S. Beech's Paper, published in your issue of the 16th inst., attracted my attention. Mr. Beech places the date of the first Wilkinson cupola as 1770. This date is earlier than my own investigations have shown, and I should be glad if Mr. Beech would be kind enough to refer me to his authority for this date, and also the drawing of the Wilkinson cupola as shown in his Fig. 1.—Yours, etc.,

J. E. Hurst.

Burndale, Houseley, Chapeltown.
May 20, 1929.

Reports and Dividends.

Mazapil Copper Company, Limited.—Dividend of 7½ per cent. for the year 1928.

Richard Johnson & Nephew, Limited.—Dividend at the rate of 8 per cent. on the ordinary shares.

Dorman, Long & Company, Limited.—Dividend on the 6 per cent. cumulative preference shares for the half-year ended March 31 last.

John Hetherington & Sons, Limited.—Net profit, £70,579; brought in, £26,959; preference dividends, £24,685; to reserve for income-tax, £16,000; expenses of increase of capital, £2,485; dividend of 7½ per cent. for the year on the ordinary shares; carried forward, £33,394.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Net loss for 1928, after meeting interest charges, but before providing for depreciation, of £551,970, to which is added the debit of £413,772 brought forward, making a total of £965,742. Of this, £692,809 was included in the figure of £14,117,536 announced in February last as the total losses to be written off under the scheme of arrangement, which has now been sanctioned by the Court. The balance of £272,933 now falls to be added, and after crediting the share premium and debenture redemption account (£189,297), the total losses to be written off under the scheme of arrangement amount to £14,201,172. The general reserve shows a reduction of £214,096 to £285,904. This is accounted for by the fact that under the scheme of arrangement the Scotswood and other works were valued on the basis of new construction being completed; accordingly, £187,443, representing capital expenditure on those works since June 30, and £26,652, in respect of sundry old investments, have been written off.

Catalogues Received.

Goggles, Helmets and Respirators.

We cannot urge too strongly upon foundry owners to study with the greatest care the potentialities offered by the modern goggle manufacturer. We have often participated in the past in discussions between management and operatives on this subject. We have heard and appreciated the objections launched by workers, who have insisted that the glasses under consideration were too heavy; insanitary; uncomfortable; inadequately ventilated; burnt the nose-bridge, and a host of associated complaints. Bearing these objections in mind, we have studied carefully the latest eight-page catalogue issued by Messrs. H. G. Sommerfield, Limited, of Charterhouse Chambers, Charterhouse Square, London, E.C.1, and have noted how completely all these problems have been overcome. It is now possible to provide the foundry staff, whether on the furnace platform, in the grinding and fettling shops, or in the welding department with goggles of a suitable character for each type of work. As this particular activity has a humanitarian aspect, we are of opinion that every foundry owner should be in the position of being able to state, that whatever can be done in the direction of conserving the operatives' eyesight has been done. Like many other humanitarian efforts, it will probably make a monetary return from increased efficiency. Included in this well-laid-out catalogue are sections dealing with the associated problems of the provision of respirators and sand-blast helmets.

A Core-Making Machine.

Mr. Ralph Wilson, of 6, Cobden Street, Wednesbury, Staffs, in a 4-page leaflet, illustrates and describes a new type of core-making machine, which he has called the "Perfect Core" machine. For use with the machine a cast-iron bush is prepared as a core-box, but its base is formed by an adjustable internal plate, and only the exact length of the core is rammed up by hand. The core is stripped from the bush by the operation of a hand wheel. This, of course, eliminates rapping and dissembling and reassembling the two halves of a core-box. Arrangements are incorporated for making cores of irregular shape. To the best of our knowledge, this machine marks a new departure in core-making contrivances.

Contracts Open.

Croydon, June 3. — One 20/25,000-kw. turbo-alternator, complete with condensing plant, pumps, piping, valves, etc., two 100,000-lb.-per-hr. boilers and stand-by coal conveyor, and 6,600-volt switchgear, transformers, etc., for the Town Council. The Engineer and Manager, Electric House, 38, High Street, Croydon. (Fee £1 1s. for each section, returnable.)

Hamilton, June 5.—400-h.p. Diesel engine and a.c. generator, for the City of Hamilton. The Department of Overseas Trade. (Reference B.X. 5,287.)

Isleworth, June 25.—Two boilers (vertical or economic dry-back type), water-softening plant, and 600 yds. of 4-in. cast-iron and wrought-iron water main and two steam-driven pumps, for the Brentford Board of Guardians. Mr. F. E. Harmsworth, clerk, 34, Twickenham Road, Isleworth. (Fee £5, returnable.)

Santiago, June 20.—Fishplates, chairs, bolts, spikes and washers, for the Chilean State Railways. The Department of Overseas Trade. (Reference A.X. 7,879.)

Wellington, N.Z., August 13.—Water turbine-driven generating sets and switchgear, for the Public Works Department, Wellington. The Department of Overseas Trade. (Reference B.X. 5,278.)

The directors of the Yorkshire Copper Works, Limited, propose to increase the nominal capital of the company by £50,000.

Random Shots.

Although we must modestly disclaim entire responsibility, we do feel rather pleased at the way things have panned out over this election business. We could almost add to the programme prepared for our foreign visitors something of this sort:—

STUPENDOUS ATTRACTION!!!

The first for five years, the last for a lifetime!
Positively

a

Genuine GENERAL ELECTION!!!!!

Couldn't we, now?

* * *

But between you and me and the lamp-post, can you remember another such dull election in all your life? If it is the refining influence of the women's vote, then heaven preserve us from any further extension of the franchise! No, politics are not what they were!

* * *

Not what they were, for instance, a hundred years ago. In those happy days, before the Reform Bills that we used to read about in our history books, an election really was an election. There were glorious free fights, there were gallons of beer, there was shouting and excitement. Of course, you didn't vote—that was reserved for a few landowners and lordlings, who usually managed to arrange these matters very conveniently to suit themselves. But that was really rather an advantage than otherwise, since it enabled you to enjoy the fun without feeling called upon to pay for it in any way. Women? Oh, they stayed at home, where, in those far-off happy days, they belonged, and they prepared poultices and patches for the broken heads and the torn coats that they were wise enough to expect when politics were in the wind.

* * *

This little story was told at a recent business luncheon to give point to some remarks on the state of British trade. An American planning a big-game hunting expedition was a little damped when his wife decided to come along too. He was more than a little damped when his wife's mother also decided to come along too. However, being an American, what could he do? In the course of the expedition, one night the elder lady felt rather restless, and wandered out into the jungle. Her daughter, watching, was horrified to see that she was being stalked by a huge man-eating lion. "Look!" she cried to her husband. "Look at mother!" "I'm looking," he said, very wearily. "Well, but aren't you going to *do* anything?" "Do anything? Of course I'm not going to do anything. The lion has got himself into this mess, and he can get himself out of it!"

* * *

And did you hear this one of the judge and the coloured gentleman in a certain Southern American state?

Judge: "Do you plead guilty or not guilty?"

Prisoner: "Not guilty."

Judge: "Then wha' d'you mean wasting our time here?"

* * *

From Marksman's Own Collection of Howlers:—

"Double dealing is when you buy something wholesale to sell retail."

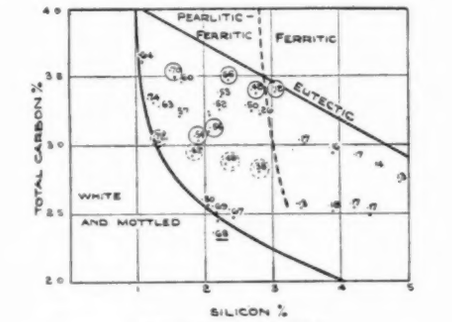
Marksman.

Constitutional Diagrams for Cast Irons and Quenched Steels.*

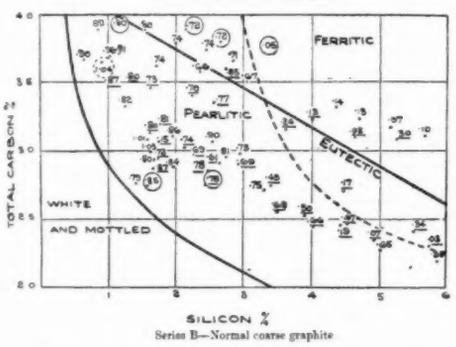
By A. L. Norbury, D.Sc.

While making a number of crucible melts of grey cast irons of various total carbon and silicon contents, from mixtures of Swedish white iron, Armco iron, ferro-silicon, ferro-manganese, and ferro-phosphorus, it was found that in many cases irons having identical chemical compositions, cast under identical conditions (but melted under different conditions), had widely different microstructures, combined carbon contents, tendencies to chill, and mechanical properties.

Typical microstructures of medium silicon grey irons of similar chemical compositions, but different microstructures, are shown in Figs. 16 and 17, while similar micrographs for high-silicon irons are shown in Figs. 18 and 19.

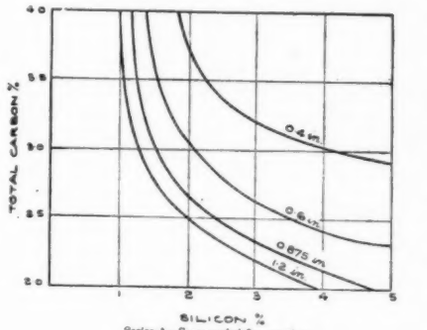


Series A—Supercooled fine graphite.

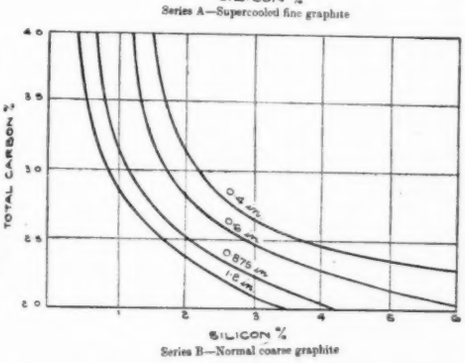


Series B—Normal coarse graphite

FIG. 1.—COMBINED CARBON CONTENTS OF 1.2 DIA. SAND-CAST BARS.



Series A—Supercooled fine graphite



Series B—Normal coarse graphite

FIG. 2.—CHILL LINES DIVIDING GREY IRONS FROM WHITE AND MOTTLED FOR VARYING DIA. SAND-CAST BARS, PLOTTED, AGAINST TOTAL CARBON AND SILICON CONTENTS.

In one type of iron the graphite is in a very finely-divided form, which has been called "supercooled graphite," whereas in the other type of iron the graphite is in the form of relatively coarse flakes, which has been termed "normal graphite." (All intermediate sizes have also been obtained.) It has also invariably been found that the fine graphite tends to be associated with ferrite in the matrix, while the coarse graphite tends to be associated with pearlite in the matrix—for silicon contents below about 3 per cent. Fine (supercooled) graphite structures similar to the above have been obtained by Piwowarsky,[1] Hanemann,[2] Bardenheuer, Zeyen[3] and others by superheating the melt. The explanation advanced by these investigators is that the refining of the graphite is due to the destruction of graphite nuclei in the melt. Schüz[4] has obtained similar structures by casting high-silicon (3.5 per cent. silicon) irons in chill moulds. Irresberger[5] has obtained them by jolting molten cast iron which has been melted with steel additions. This fine graphite structure had also been obtained—as shown by their micrographs—by earlier investigators—for instance, Hague and Turner,[6] Coe,[7] etc. By controlling the melting conditions in the above-mentioned crucible melts it was possible to make two types of grey iron, which have been grouped as Series A and Series B, respectively. In Series A the graphite was largely of the fine (supercooled) type, although a certain amount of coarser graphite was also present in certain cases. In Series B, on the other hand, the graphite was almost entirely of the coarse (normal) type.

The combined carbon contents of 1.2-in. dia. sand-cast bars of Series A and Series B irons are shown in Fig. 1, plotted against total carbon contents vertically and silicon contents horizontally. The manganese contents were 1 per cent. in all cases, except where a full circle has been drawn round a combined carbon content, which indicates a manganese content of 0.3 per cent., or a dotted circle which indicates a manganese content of 0.6 per cent. The phosphorus contents were 0.03 per cent. in all cases, except where a line has been drawn beneath the number, which indicates a phosphorus content of 0.3 per cent. The sulphur contents were 0.03 per cent. in all cases.

Curved chill lines have been drawn which separate grey-iron bars from the white and mottled-iron bars. Lines showing the effect of silicon on the carbon content of the eutectic have also been included, also dotted curves dividing pearlitic-ferritic irons from ferritic irons in Series A and pearlitic irons from ferritic irons in Series B. It will be noted that the combined carbon contents of irons in Series A are lower than those of irons of similar chemical composition in Series B, which is in agreement with the microstructures referred to above.

Chill curves—that is to say, curves dividing white and mottled irons from grey irons—for 1.2-in., 0.875-in., 0.6-in. and 0.4-in. dia. sand-cast bars are shown in Fig. 2. It will be seen that the irons in Series A of the supercooled (fine) graphite type show a considerably greater tendency to chill than irons in Series B of the normal (coarse) graphite type. It is noteworthy that irons in series A show an increased tendency to chill, but have lower carbon contents on solidifying grey. The fractures of the grey iron bars were also markedly different.

In Series A the fractures tended to be very finely granular, and dull black or sooty in appearance. A typical fracture of a 0.875-in. dia. sand-cast bar in series A, containing total carbon 2.81, combined carbon 0.14, silicon 4.53, manganese 0.98, sulphur 0.03, and phosphorus 0.03 per cent., is shown in Fig. 20. In series B, on the other hand, the fractures tended to be coarsely granular, to be steely-grey rather than dull black, and to contain numerous shining graphite flakes. A typical fracture is shown in Fig. 21 of an iron in series B containing total carbon 2.71, combined carbon 0.17, silicon 4.46, manganese 1.10, sulphur 0.03, and phosphorus 0.30 per cent.—that is, of similar composition to that shown in Fig. 20. (Figs. 20 and 21 were photographed on the same plate.) The fractures are, of course, also largely dependent on the total carbon and silicon contents.

The fractures of the mottled bars were also different in irons in series A and B, as shown in Figs. 3 and 4. In Fig. 3 the white fracture contains spots of supercooled graphite throughout, and a ring of supercooled graphite round the edge. Bardenheuer and Zeyen[3] (*loc. cit.*, p. 362) have suggested that supercooled graphite is formed by the sand particles of the mould acting as nuclei. It seems likely, however, that its formation is also due to the fact that the outer layers are able to undergo more readily the expansion necessary for graphitisation. Except in the graphitised spots, the inside layers have been prevented from solidifying grey with consequent expansion, owing to the resistance and pressure exerted by the contraction of the solidified outer layers. The form of this graphitisation is reminiscent of troostite in martensite. The fractures of mottled bars of series B type shown in Fig. 4 were normal—namely, white on the outside and grey in the centre, consequent

FIG. 3.—MOTTLED FRACTURE, TYPICAL OF IRONS IN SERIES A (SUPERCOOLED FINE GRAPHITE TYPE). NATURAL SIZE.

FIG. 4.—MOTTLED FRACTURE, TYPICAL OF IRONS IN SERIES B (NORMAL COARSE GRAPHITE TYPE). NATURAL SIZE.

FIG. 5. — PIPE, TYPICAL OF IRONS IN SERIES A.

FIG. 6. — PIPE, TYPICAL OF IRONS, SERIES B.

* A Paper presented to the Iron and Steel Institute at the Annual London Meeting.

on the retardation of the rate of cooling from the edge to the centre.

The internal pressure consequent on supercooling followed by the expansion due to an iron of Series A type solidifying grey is indicated by the nature of the pipe shown in Fig. 5. In such a case the expansion accompanying the deposition of graphite from the melt has caused the eutectic, which was still liquid between solid austenite dendrites in the central portion of the hypo-eutectic test-bar, to be squeezed so that it has been extruded and formed globules in the pipe. (Microscopic examination showed that such globules were of eutectic composition.) If the conditions are suitable, the pressure may be sufficient to prevent the central portion solidifying grey—in which case internal chill will again result. The pipes in the Series B type of iron (as shown in Fig. 6) were normal—that is, they contained no extruded globules.

The phosphide network structures at a magnification of 25 dia. obtained by deep etching in nitric acid (sp. gr. 1.2) were larger in the grey irons in Series A than in the grey irons in Series B. Typical networks of irons in Series A and B are shown respectively in Figs. 22 and 23. These networks are presumably due to the crystallisation of the liquid eutectic (contained between the solid austenite dendrites) proceeding from a limited number of centres. From each centre the crystallisation proceeds outwards until it meets crystallisation proceeding from a neighbouring centre. The last portions of eutectic to solidify (the phosphide eutectic) consequently crystallise farthest away from the centres and give the network structure. The fact that the network size is larger in Series A than in Series B may be due to the slower rate of solidification consequent on supercooling.

In order to explain the above results and certain others which will be referred to in due course, constitutional diagrams for cast irons have been constructed in which normal and supercooled systems are shown.

Analogy with Aluminium-Silicon Alloys.—A similar type of equilibrium diagram showing normal and supercooled systems* has recently been proposed for the aluminium-silicon alloy system by Gwyer and Phillips,[4] Gayler[5] and others. The microstructures of modified (supercooled) and normal aluminium-silicon alloys (shown in their Papers) are strikingly similar to those shown in Figs. 16 to 19. The modified aluminium-silicon alloys are obtained by chilling, or by adding metallic sodium or caustic soda or certain other modifiers to the melt. The precise action of these modifiers is not completely understood, but, from analogy with cast iron, it may consist in fluxing and removing from the melt particles—such as oxides—which act as nuclei. It is suggested that the fine and coarse graphite structures obtained in grey cast irons are analogous to the fine and coarse structures obtained in modified and normal aluminium-silicon alloys. Constitutional diagrams have consequently been constructed for cast iron showing normal and supercooled systems, both for the austenite-graphite system and for the austenite-cementite system. In view of the considerable effect of silicon on the positions of the phase boundaries, three iron-carbon diagrams have been constructed, one for 0 per cent. of silicon, one for 2 per cent. of silicon, and one for 4 per cent. of silicon, as shown in Figs. 7, 8 and 9.

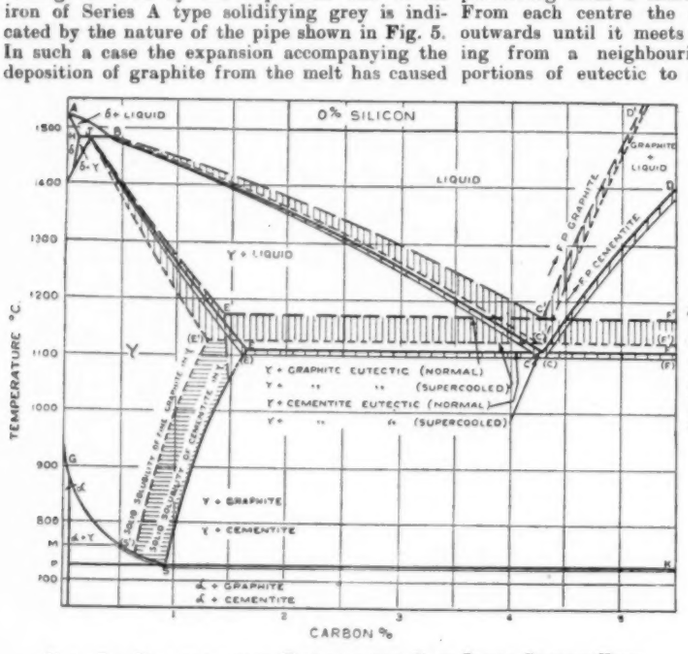


Fig. 7.—Constitutional Diagram for Cast Irons Silicon-Free.

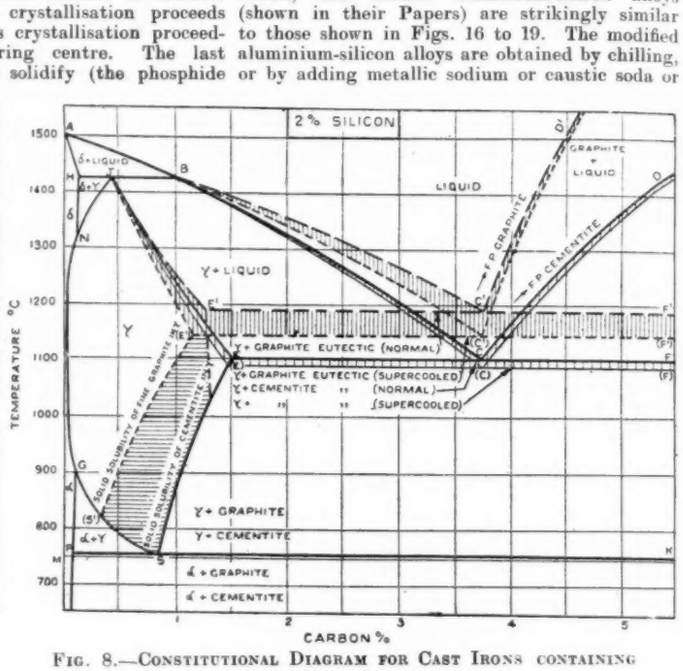


Fig. 8.—Constitutional Diagram for Cast Irons containing 2 per Cent. Silicon.

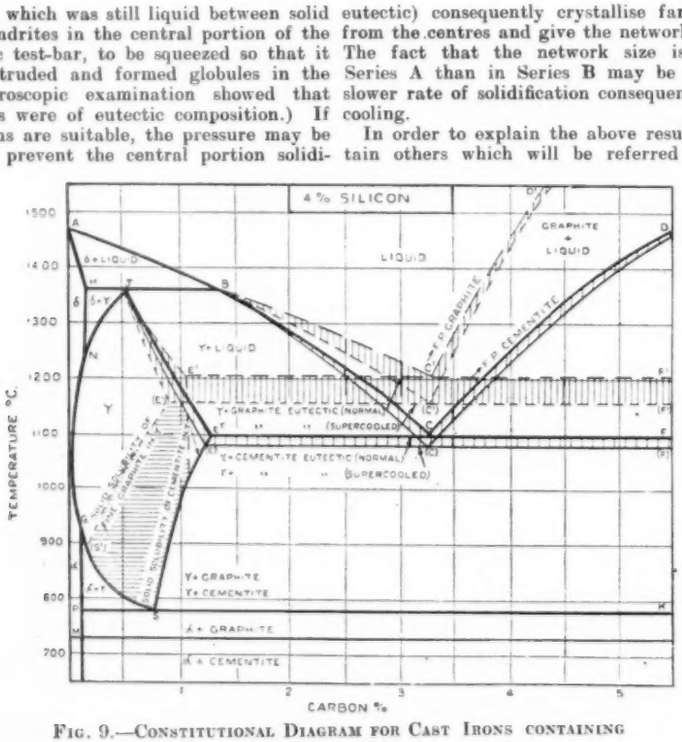


Fig. 9.—Constitutional Diagram for Cast Irons containing 4 per Cent. Silicon.

Positions of Phase Boundaries in Iron-Carbon-Silicon Diagrams.—The temperatures and compositions assigned to the phase boundaries in the 0, 2 and 4 per cent. silicon constitutional diagrams shown in Figs. 7, 8 and 9 have been taken from various sources. It is realised that in many cases the positions assigned are only approximately correct, and experiments are being carried out with the object of ascertaining them more accurately.

Normal and Supercooled Austenite-Graphite and Austenite-Cementite Eutectic Temperatures.—The temperatures assigned to the fine graphite and coarse graphite eutectics, respectively, in Figs. 7, 8 and 9, have been arrived at from a consideration of the results of Wüst and Petersen[10] and Hague and Turner,[6] plotted in Fig. 10. It will be seen that the eutectic temperatures found by Wüst and Petersen are some 20 deg. higher than those found by Hague and Turner. Wüst and Petersen had excess carbon present in their melts, and it is suggested that this excess carbon provided the nuclei which prevented supercooling and caused the melts to solidify according to the coarse graphite eutectic.

Micrographs published by Hague and Turner show, on the other hand, supercooled graphite eutectic structures in all cases. It consequently seems probable that the lower eutectic tempera-

* Diagrams showing normal and supercooled systems were first proposed by Miers and his collaborators to represent the crystallisation of various substances from aqueous and organic solutions. The principles of supercooling, etc., enunciated have also been applied to alloy systems by Huntington and Desch, Stead, Portevin, Hallimond and others. (*See* Miers[14] and Hallimond[15].)

tures found by them are representative of the supercooled eutectic. The temperatures assigned to the course eutectics in Figs. 7, 8 and 9 have consequently been taken from the data of Wüst and Petersen, while the temperatures for the fine graphite eutectics have been taken from the data of Hague and Turner.

Normal and supercooled eutectic lines for white irons have also been drawn in Figs. 7, 8 and 9. This appears to be probable from a consideration of the microstructures shown in Figs. 24 and 25. The irons shown in these figures contained carbon 3.9 and silicon 0.6 per cent., and were practically identical in chemical composition; they were crucible-melted and sand-cast in the form of 1-in. × ½-in. bars under practically identical conditions. Fig. 24 was a Swedish pig-iron plus 10 per cent. ferro-silicon mixture, and Fig. 25 was a refined pig-iron plus

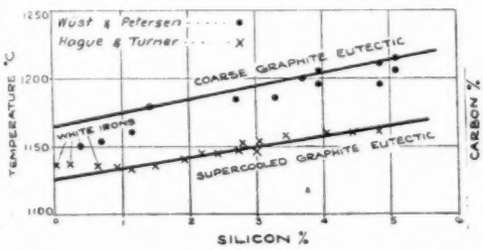


Fig. 10.—Effect of Silicon on the Austenite-Graphite Eutectic Temperature.

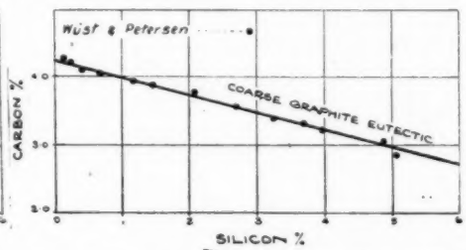


Fig. 11.—Effect of Silicon on the Carbon Content of the Austenite-Graphite Eutectic.

arc carbon mixture. It will be seen, however, that in Fig. 25 the austenite part of the eutectic has coagulated and joined up with the primary austenite dendrites, while in Fig. 24 this has not occurred. It is suggested, therefore, that Fig. 24 represents the supercooled eutectic, and that the microstructure in Fig. 25 indicates that after the austenite dendrites had solidified there were graphite or other nuclei present in the still molten eutectic which caused the precipitation of small amounts of austenite-graphite eutectic, which in turn caused the precipitation of the white iron eutectic at its highest possible temperature, with consequent maximum coalescence.

The γ + cementite normal eutectic has been placed at 1,110 deg. C. in Fig. 7, and at 1,105 deg. C. and 1,100 deg. C. in Figs. 8 and 9, while the supercooled eutectic has been placed 10, 15

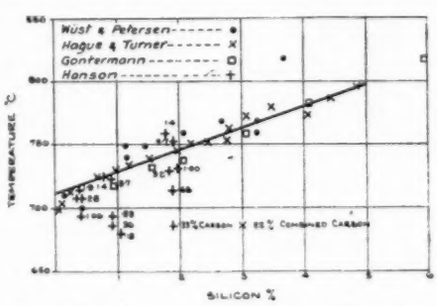


Fig. 12.—Effect of Silicon on Pearlite Precipitation.

and 20 deg. lower in each diagram. The temperatures of these eutectics are not known with any degree of certainty. The letters representing the supercooled systems in Figs. 7, 8 and 9 have been enclosed in brackets.

Carbon Contents of Normal and Supercooled Eutectics.—The point *C'* for the coarse graphite eutectic has been placed at 4.3 per cent. of carbon for 0 per cent. of silicon, 3.75 per cent. of carbon for 2 per cent. of silicon, and 3.25 per cent. of carbon for 4 per cent. of silicon, in accordance with the data of Wüst and Petersen,[10] plotted in Fig. 11. The effect of silicon on the carbon content of the fine graphite eutectic is apparently approximately the same, since the microstructures of alloys containing 3.5 per cent. of silicon and about 3.3 per cent. of carbon showed areas of supercooled graphite of approximately eutectic structure. The effect of silicon on the carbon content of the white iron (austenite-cementite eutectic) also appears to be approximately the same, judging by planimetric measurements on microstructures of white irons containing about 3 per cent. of silicon. The normal and supercooled graphite-austenite and cementite-austenite eutectic compositions have consequently been placed at the same carbon contents in each of the diagrams.

Liquidus Lines.—Liquidus lines have been drawn in, joining the four eutectic points with the point *J* on the low-carbon side of the eutectics, and the freezing points of graphite and cementite, respectively, on the high-carbon side of the eutectics.

Solid Solubility of Graphite and Cementite in γ-Iron.—The lines (*S'*)(*E'*), representing the solid solubility of graphite in γ-iron in the 0, 2, and 4 per cent. silicon diagrams have been taken from the work of Morschel.* The positions of the

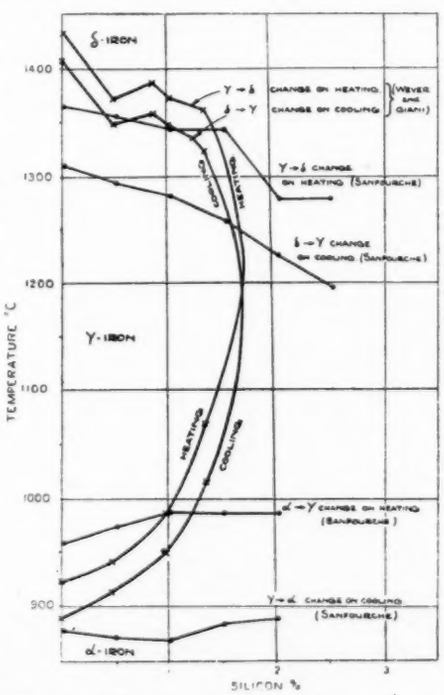


Fig. 13.—Effect of Silicon on the δ, γ and α Allotropic Transformations.

points *E'* in Figs. 7, 8 and 9, obtained by the intersection of these graphite solid-solubility lines and the coarse graphite eutectic temperature lines, have been checked by chemical analysis in the following manner. It has been found† that if manganese is only present in traces in cast iron, the secondary cementite is stabilised by traces of sulphur and does not decompose into graphite. Coarse graphite irons of this type containing 2 per cent. and 4 per cent. of silicon, respectively, have been found to have combined carbon contents approximating to the values shown for the points *E'* in the diagrams in Figs. 8 and 9. The position of the points (*E'*) has been checked in a similar manner with fine graphite alloys. The line *SE* for the solid

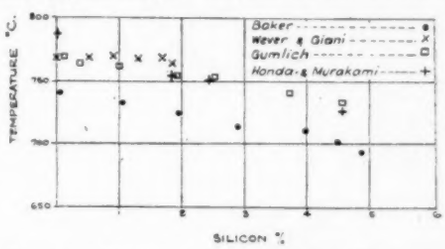


Fig. 14.—Effect of Silicon on the Temperature of the β-α Magnetic Change.

solubility of the cementite in γ-iron has been taken from the diagram published by the Verein deutscher Eisenhüttenleute,* and has been moved to the left slightly (that is, to lower solid solubilities) for increasing silicon contents. The position of point *E* for high silicon contents is not, however, known with certainty.

Eutectoid Carbon Content and Eutectoid Temperature.

The point *S* has been placed at 0.9 per cent. of carbon for 0 per cent. of silicon, and its carbon content with 2 per cent. and

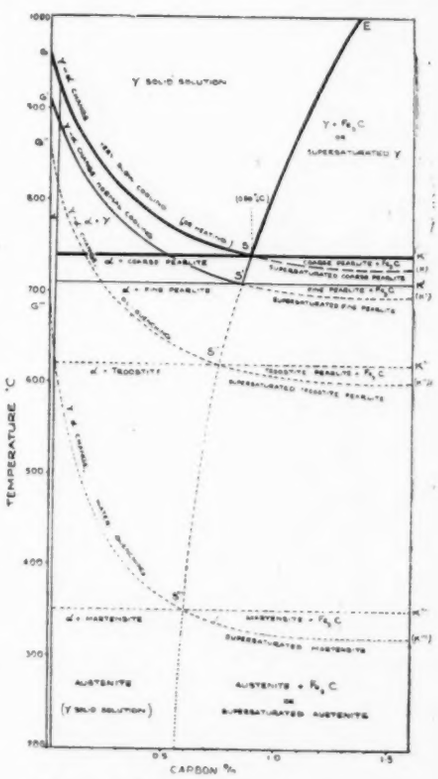


Fig. 15.—Constitutional Diagram for Quenched Steels.

4 per cent. of silicon has been estimated in the following manner. Grey irons containing coarse graphite in a uniformly pearlitic matrix have been obtained with silicon contents as high as 4 per cent. and over. With 4 per cent. of silicon the combined carbon content of such irons has been found to be 0.7 per cent. (see Fig. 1), which figure has consequently been taken to

* See Schüz (*loc. cit.*, p. 387).
† Paper to be presented to the I.B.F., June, 1929.

* See Schüz (*loc. cit.*, p. 383).

represent the carbon content at the point *S* in Fig. 9. The lines *PSK* have been placed at 720 deg. C. for 0 per cent. of silicon, 750 deg. C. for 2 per cent. of silicon, and 780 deg. C. for 4 per cent. of silicon. This raising of the eutectoid temperature has been taken from the results of Wüst and Peterson,[10] Hague and Turner,[6] Gontermann,[11] and Hanson,[12] plotted in Fig. 12. Incidentally, with low carbon contents—that is, below 0.9 per cent.—considerably lower temperatures for this line have been found by others, as shown by the results plotted in Fig. 12, where low carbon contents have been written in against the dots, etc. It is suggested that this is due to supercooling consequent on the absence of carbide nuclei.

δ-γ and γ-α Allotropic Changes.—The lines *AB* and *BH* have been taken from the work of Ruer and Klesper for 0-per-cent. silicon alloys; for 2-per-cent. silicon alloys (Fig. 8) they have been taken from the work of Hanson, while for 4-per-cent. silicon alloys (Fig. 9) extrapolated values have been estimated from these two investigations. The point *M*, at which δ-γ change takes place, has been placed for 0 per cent. of silicon according to the work of Ruer and Klesper,[16] of Wever and Giani,[17] and of Sanfourche,[18] whose results are plotted in Fig. 13. In higher silicon contents the δ-γ change does not occur, according to the results of Wever and Giani, which confirmed the prediction of Oberhoffer.[19] These investigators found that the δ-γ change was absent in alloys containing over 1.5 per cent. of silicon; they worked, however, with alloys made from exceedingly pure electrolytic iron. A similar line has been drawn in the 4-per-cent. silicon diagram with the saturation carbon content of the α and δ solid solutions increased. A comparison of the work of Ruer and Klesper[16] with 0 per cent. of silicon, and Hanson[12] with 2 per cent. of silicon, also suggests that the solubility of carbon in δ-iron increases as the silicon is increased from 0 to 4 per cent., since Hanson found a greater solubility of carbon in δ-iron than Ruer and Klesper did. In higher silicon contents the δ-γ change does not occur, according to the results of other investigators. It has been found that the δ-γ change was absent in alloys containing over 1.5 per cent. of silicon; they worked, however, with alloys made from exceedingly pure electrolytic iron. Sanfourche,[18] on the other hand, working with alloys made from Swedish wrought iron containing a few thousandths per cent. of carbon, found the δ-γ change was lowered from about 1,380 deg. C. with 0 per cent. of silicon to 1,300 deg. C. with 2 per cent. of silicon, as shown in Fig. 13. The difference between these two sets of results may be explained by assuming that carbon affects the temperatures at which the change takes place in the manner shown in Figs. 7, 8 and 9. In Fig. 8, for 2-per-cent. silicon alloys, the point *N* has been placed at about 0.1 per cent. of carbon and 1,300 deg. C., and the α solid solution, which contains about 0.03 per cent. of carbon at 720 deg. C., according to the recent work of Whiteley,[20] has been continued inwards—that is, for lower carbon contents—to meet the δ solid solution at high temperatures without any intermediate γ formation. That silicon increases the solubility of carbon in α-iron is also indicated by evidence yielded by later work, namely, that 4-per-cent. silicon grey cast irons can hold about 0.1 per cent. of carbon in solid solution.

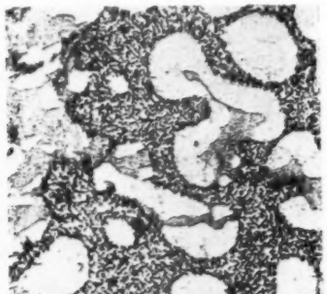


Fig. 16.—Supercooled (Fine) Graphite, Ferrite and Pearlite in Medium-Silicon Grey Iron. × 200. T.C., 2.91 per Cent.; C.C., 0.62 per Cent.; Si, 1.82 per Cent.; Mn, 0.67 per Cent.; S, 0.03 per Cent.; P, 0.03 per Cent.

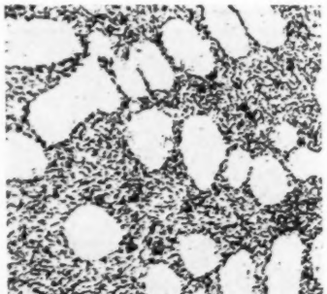


Fig. 18.—Supercooled (Fine) Graphite in Ferrite in High-Silicon Grey Iron. × 200. T.C., 2.81 per Cent.; C.C., 0.14 per Cent.; Si, 4.53 per Cent.; Mn, 0.98 per Cent.; S, 0.03 per Cent.; P, 0.03 per Cent.

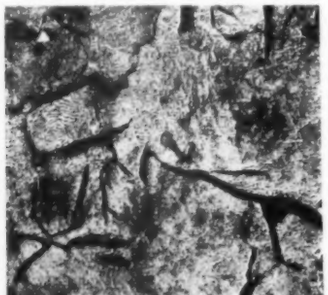


Fig. 17.—Normal (Coarse) Graphite in Pearlite in Iron of Similar Composition to that in Fig. 16. × 200. T.C., 2.94 per Cent.; C.C., 0.80 per Cent.; Si, 1.70 per Cent.; Mn, 1.00 per Cent.; S, 0.03 per Cent.; P, 0.03 per Cent.

Fig. 19.—Normal (Coarse) Graphite in Ferrite, also Patches of Phosphide and Pearlite, in Iron of Similar Composition to that in Fig. 18. × 200. T.C., 2.71 per Cent.; C.C., 0.17 per Cent.; Si, 4.46 per Cent.; Mn, 1.10 per Cent.; S, 0.03 per Cent.; P, 0.30 per Cent.

(Figs. 16 to 19 etched in Alcoholic Picric Acid.)

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Tamura[21] has suggested that the solid-solubility curve of carbon in δ-iron can be regarded as a continuation at high temperatures of the curve showing the solid solubility of carbon in α-iron.

Magnetic Change.—In Fig. 14 the magnetic change *M* occurs at about 768 deg. C. for 0 per cent. of silicon, and is lowered to 720 deg. C. by meeting the line *GS"S*, since it cannot occur until the γ-α change has taken place. The change appears to be lowered by about 10 deg. for each 1 per cent. of silicon, according to the results of Baker,[22] Gumlich,[23] Wever and Giani,[17] and Honda and Murakami,[13] plotted in Fig. 14.

(To be continued.)

Fig. 20.—Close-grained Dull Sooty Fracture, typical of Grey Irons in Series A. Natural Size.

Fig. 21.—Coarse-grained Fracture containing Shining Graphite Flakes, typical of Irons in Series B. Natural Size.

Tungsten-Carbide Tools.—From time to time we have referred to the value of these tools, and a recent issue of the "Iron Trade Review" states it is now apparent that the use of the tungsten-carbide tools will affect machine design, will permit machines now employed at only a fraction of their capacity to be utilised to the full extent of their power and speed, and will develop new grinding procedure for dressing tungsten-carbide material.

The Design and Operation of the Cupola.

By A. S. Beech.

(*Continued from page 356.*)

Tuyeres.

The duty of the tuyeres is solely to bring an adequate air supply in order to burn the fuel. From the experiments of Guettier and Moline, who both used simple round tuyeres, one is led to the conclusion that the shape of the tuyere is of very little importance. Moreover, at the end of the tuyere the wind comes up against pieces of coke, which partially obstruct it and force it almost immediately to divide itself into small streams so that the real passage left for the air is not only a fraction of the surface of the tuyeres themselves. Tuyeres should be made in such a manner that they are easy to close, so that if they become dirty during working they can be readily closed and cleaned.

If the top hole is botted up, and consequently the only exit for the blast is the top of the cupola, the wind is inflected from the tuyeres towards the top, and as its force is somewhat broken by the coke, it follows that there is a tendency to penetrate towards the centre of the cupola. As cupolas increase in size, however, this tendency lessens naturally, and this is one of the reasons why it is advisable to have two cupolas of smaller dimensions rather than one large cupola serving the whole foundry. In

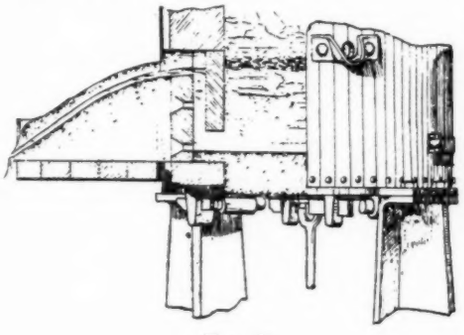

Fig. 6.

general, tuyeres should be as large as possible, and without complications, and arranged in such a manner as to be limited in height, thus reducing the height of the melting zone, and to eliminate, especially in large cupolas, sections which receive no air. No useful purpose is served by two rows of tuyeres.

The general principle of cupola melting has not altered very much since 1854, when Guettier insisted that it was possible to work under excellent conditions with a single row of tuyeres, and proved his contentions.

Moldenke also came to the same conclusion more than fifty years later. However, the best indication of all is to be found in the fact that in many cupolas having two rows of tuyeres the second row of tuyeres is blocked up.

Syphon Brick.

Fig. 6 shows that the syphon system consists in placing a brick in the front of the cupola, which has its back level with the hearth. It also has a hole which communicates with the interior of the cupola and a vertical passage in the centre, with three holes in the front. Whilst it is working the two lower holes are botted up, so that when the iron leaves the lower part of the bath it goes up through the syphon brick, by means of the vertical passage, and flows out through the top hole.

There is, therefore, a certain height of the metal in the cupola surmounted by a bed of slag on which the pressure of wind acts. The three pressures, metal, slag and wind, compel the iron to rise up the passage and flow down the outside top hole.

If momentarily one cut off the wind pressure, which is in the region of 16-in. water pressure, the level of the iron will descend in consequence, and the flow of metal stops; in fact, it might almost be compared with the turning on and off of a water tap. As soon as one commences to blow again, the flow recommences. It eliminates all botting-up of the top hole, whilst from the first tap the iron obtained is always clean, seeing that it is taken from the lower part of the well of metal inside the cupola. Again, it is very well mixed, and finally there is produced, because of the long contact of the metal with the slag, providing this is sufficiently basic, a measure of refining or desulphurisation of the metal. The syphon brick is made up of the following constituents:—Three parts of ground coke, four parts of good ganister, and four parts of burnt sand, old lining, or silica sand.

Receivers.

The receiver, or forehearth, originated in Germany. It has both advantages and disadvantages. The disadvantages are that it is very expensive, it is a great complication, and it means a comparatively expensive maintenance, and, above all, is very difficult to heat properly. It must be remembered further that there are two hearths to maintain, and when the metal first comes through the cupola, it is very seldom hot. The syphon brick gives all the advantages of the receiver, without any of its disadvantages, as from one point of view the syphon brick is really a receiver inside the cupola.

The pouring spout of the cupola should consist of a detachable channel lined with sand. It can be made either in sheet steel or iron. It is advisable to fix it on to the main casing of the cupola, by an arrangement of keys. It is preferable to build this in a U-shape or in an angle. Good and bad arrangements for the spout are shown in Fig. 7. The lining of a cupola can be made either with bricks or with a plastic refractory. Bad brickwork can induce many serious inconveniences through the joints. It is essential that the bricks are of an appropriate shape to the horizontal plan, leaving as few joints as possible. The average thickness of lining in Europe is in the region of 9 in. In America, however, it is much less, probably because of the difference in the nature of the linings. It is usually customary to leave a small space between the lining and the casing of the cupola, which is generally filled with sand in order to permit of the expansion of the casing. The plastic lining should be made with the same composition outlined for making a syphon brick. The results obtained in the author's cupolas have been excellent, and this can be done at a moderately cheap price, and has the advantages of not having any joints in the inside of the lining. On the other hand, if this lining could be made with carbon bricks at a reasonable price, this would be ideal. As the linings have to be repaired and the repairs dried afterwards, it is always advisable to provide vents for the gases. The general rule is to provide the top of the lining with cast-iron bricks, at a distance of approximately 40 in. between the top of the lining and the charging hole.

Platform.

The platform may be considered as the necessary part of the furnace. It may be ordinary earth, which has the advantage of being very solid, but, in any case, it is necessary to see that it is very strong in order to carry the large charges of iron, which are generally put on to the platform. There is, however, at the present time a tendency to eliminate the platform and use an automatic charging-device.

Working the Cupola.

The best way to ascertain its working is to go inside the cupola each morning and examine the state of the lining, as it gives valuable information regarding the melting. If, for example, the melting zone is too large, one can immediately conclude that the cupola has been badly worked. The melting zone rises up to within approximately 20 to 25 in. from the tuyeres. The lining should, therefore, be burnt away at this particular point. If the worn zone is larger, it is because the melting zone has been deplaced during the working of the cupola, and one can therefore state whether the charging has been badly or well carried out. When putting the cupola into operation, the height of the coke above the tuyeres must be determined. This height can vary to a certain extent, according to the cupola, and also with the size and quality of the coke used, and on the velocity of the blast, and, finally, to a certain measure, on the proportions of the cupola. A practical means of determining for a given cupola what the height of the coke bed should be consists of commencing with an exaggerated height, say 35 in., and then noting the exact moment the iron arrives, and, above all, its temperature. The next day put two inches less in the cupola and descend progressively each day by this amount. One will thus ascertain, in passing from the maximum height to the minimum, that there is a point where the temperature of the metal is highest. This height is chosen and maintained for working the cupola ever after. One can ensure that this height is maintained by passing through the charging hole a gauge, consisting of a chain at the end of which is a weight. It is also necessary to control the blast and the size of the coke. When the height of the melting zone is too great, fuel is wasted. When it is too low the iron is oxidised and cold. Moldenke insists that a continuous trickle of

Fig. 7.

iron should be produced at the tap hole in round about eight minutes after starting the blast, but certainly at the maximum within ten minutes. Of course, it must be borne in mind that Moldenke was studying large American cupolas when he gave this opinion, but with ordinary cupolas, having 28 in. of coke above the tuyeres, the iron arrives in four to five minutes after commencing blowing.

Further, Moldenke indicates that the importance and size of the charges should be determined by the following means:—Make with bricks a ring 4 in. high of the same diameter as the cupola at the melting zone, and fill this with coke, which it is necessary to weigh. Thus the charge of coke and the charge of metal established proportionately. That is to say, if one has decided, for example, the proportion of 10 per cent. of coke for melting, one multiplies the weight of the coke given by ten. Naturally, it is advisable to adjust the figures to simplify the work of weighing and charging. Actually, personal experience has shown that this height of 4 in. recommended by Moldenke should be extended somewhat, and raising it to 6 or 8 in. is advised. Working thus, a very hot and non-oxidised iron with a very reasonable coke consumption is always obtained.

There is no inconvenience in damping the coke, particularly when the charges are small. This combats the tendency in the charges to ignite from place to place in the cupola, which

would take place if the charges were very small, and would eventually turn the cupola into a gas producer. Obviously, when the coke is damp, it is necessary to take into account the weight of water when calculating the charges, but there is no necessity to damp the coke when the charges are larger.

Composition of Charges.

The charges usually consist of pig-iron, scrap iron of various sorts and of steel. The cupola functions differently according to the method of charging. It seems logical to charge the steel first, then the heavy scrap, and finally the light scrap. In acting in this manner there is much more chance to obtain an equalised melting of the charge. The very small pieces, shot or any additions of ferro-alloys, should be contained in tube ends, tins or wooden boxes, loosely closed, so as to permit the easy escape of any gases which may be formed. By this means there is no difficulty whatever in incorporating these additions to the charges. One can obtain the same results by using ferro-alloys as briquettes, made by pressure or with cement. In this form they will resist disintegration until they arrive at the melting zone.

When the run is a long one, the steel portion should be separated and the large pieces kept on one side until such times as the melting is in full swing. Very thin or very thick pieces should be eliminated, and only pieces ranging between 2½ in. up to approximately 6 to 8 in. thick should be used. Care should be paid when charging the larger pieces so as to avoid very large spaces between them, which would permit gases to pass them easily, and inversely to prevent very small pieces being crowded together and preventing the gases passing. Obviously, bridging must be prevented at all costs, as it invariably brings about a deterioration of the iron. Melting steel in a cupola necessitates an increase in the coke ratio, because the melting is more difficult on account of the carburisation of the steel, and this can only be produced by the carbon from the coke.

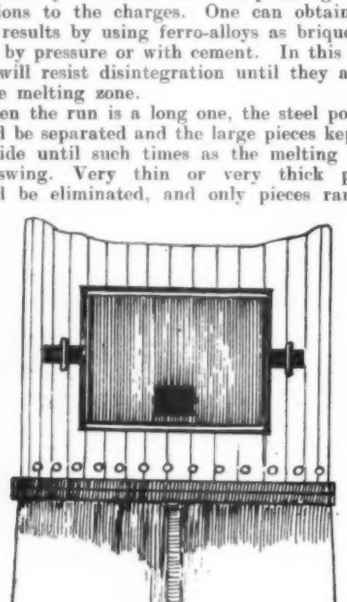

Fig. 8.

Slagging should be effected fairly frequently in order to avoid an excessive thickness of slag inside the cupola. Generally speaking, slagging should be effected every half hour to three-quarters of an hour. An intermittent removal of the slag is preferable to a continuous flow, because this latter involves a serious loss of blast, the cooling of the slag, and the production of slag wool.

The quantity of limestone to be used will depend to a great extent upon the quantity of dirt and sand that has to be slagged, and also on the purity of the limestone. The quantity used is determined from an analysis of the coke and the limestone itself. It should be as free from silica as possible. As a rule, 1 to 2 per cent. in proportion to the charges of iron is used. A slight excess of limestone is immaterial.

The slag is usually run into a hole dug in the earth close to the cupola, or into special slag receivers, or into a water tank, from which it can be later granulated.

Fig. 8 shows the back of a cupola carrying a small door in the large door. This has been incorporated, because at the bottom of the cupola there are a certain number of orifices. In a normal cupola there is the main tapping hole, but in a cupola carrying a syphon brick with three holes the little door in question is left open, whilst a steel sheet is placed on the top of the charge. If the blast is turned on into the cupola, and the lower orifices are left open, the blast passes through these openings. This will result in obtaining in two or three minutes an intensely hot hearth ready for the time when charging is going to take place.

Then take the sheet off from the top of the cupola, and check up with the gauge the height of the coke above the tuyeres, then close the little door shown in Fig. 8, and finally charge up in the ordinary way. The cupola being now full, blowing is recommenced, and it will be found that the first iron will arrive in an excessively hot condition. It is desirable to provide a written charging sheet, in order to control the charging of the cupola.

Mechanical charging does not present any difficulties if it enables one to obtain similar results to those deemed essential when hand charging. Primarily one must establish whether mechanical charging gives as good results, and secondly does it introduce any pecuniary advantage. Moldenke, Lane and many others consider it advisable to have a staff at the charging hole of the cupola, because one is never sure, particularly with small cupolas, that bridging will not occur.

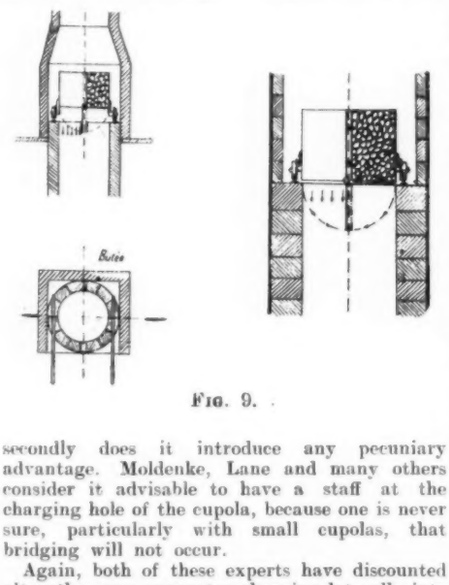

Fig. 9.

Again, both of these experts have discounted altogether any apparatus charging laterally into the cupola. Moldenke insists that when using lateral charging machine it has resulted in an expenditure of considerably more coke. Lane, too, states that automatic charging is not profitable in a cupola making less than 20 tons daily.

This trouble can be overcome where it is necessary to charge a cupola mechanically, by simply cutting the cupola over the top of the charging-hole, and spanning it by an electric overhead crane. This can place small bottom-discharging bogies into position. The method of transporting the bogies is of very little importance. The point that arises in this direction is the method in which the bogie deposits the scrap into the cupola, so as to give an even distribution of the charges. Mechanical charging presents many difficulties, and every individual case must be carefully considered to see whether any advantage is to be gained thereby, as against hand charging, and unless the advantages in favour of the automatic charging are preponderating, it is always advisable to utilise the hand-charging because of the very much better distribution of the charges. It is advantageous to recover the coke at the end of melting, and its examination is very interesting, because from it can be definitely established whether the melting has been well carried out, as shown by there being no iron mixed up with the last charges of coke (Fig. 9).

During melting, the quantity of blast should not be altered. It is much better to cut it off and switch it on again, because, by working thus, the melting zone does not change position as would certainly be the case if the pressure was varied in any way whatsoever.

It is generally conceded that the drop-bottom type of cupola is preferable. It is easily operated, and it has been proved during many years to be a complete success in the foundry. The author acknowledges with gratitude the help of Monsieur E. Ronceray, of Paris, in the preparation of this Paper.

World Engineering Congress in Japan, 1929.

Towards the end of last year a British Committee on the World Engineering Congress in Japan, representative of some twenty-six engineering institutions and technical societies, was formed, the Committee having for its objects: (*a*) The organisation of a party of British engineers to attend the World Engineering Congress at Tokyo, and (*b*) the securing of a number of Papers on engineering subjects for presentation at that Congress. As a result of the Committee's endeavours, seventy-six Papers have been contributed, and a list of the Papers has been circulated. The following Papers, likely to be of interest to our readers, are among those to be contributed:—

Institution of Civil Engineers: "Springs and Spring Materials," by R. G. Batson, M.Inst.C.E., and G. A. Hankins, D.Sc. (National Physical Laboratory). "Properties of Materials at High Temperatures," by R. G. Batson, M.Inst.C.E. (National Physical Laboratory). "The Plastic and Viscous Deformation of Metals and the Effect of Time on the Breaking Strength at Ordinary and High Temperatures," by Prof. F. C. Lea, D.Sc. "Some Points in connection with the Failure of Metals under Repeated Stresses," by the same author. "Note on Concreting a Reinforced Concrete Beam and Theory of Corrosion in Steel Reinforcing Bars," by S. D. Carothers. "Recent Progress in the Industrial Application of Alloy Steels," by Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., M.Inst.C.E. "Manganese Steel and its Developments," by the same author. "Heating Economy in Metallurgical Furnaces," by Sir Robert A. Hadfield and R. J. Sarjant, M.Sc.

Iron and Steel Institute: "The Ageing of Permanent Magnet Steels," by J. E. Gould, B.Sc.

Institution of Chemical Engineers: "By-Product Ammonia: an Economic Aspect," by P. Parrish, M.I.Chem.E. "Pulverised Fuel," by J. T. Dunn, D.Sc., and B. Moore, Ph.D., M.I.Chem.E. "The Industrial Importance of the Heterogeneous Character of Coal Seams," by F. S. Sinnatt, D.Sc., M.I.Chem.E.

Institution of Engineers and Shipbuilders in Scotland: "Shipbuilding in Great Britain," by Prof. P. A. Hillhouse, D.Sc.

Coal Research Club: "Coal Cleaning, with Special Reference to Japanese Coals," by R. Lessing, Ph.D. "The Classification of Coal," by C. A. Seyler, B.Sc.

Miscellaneous: "Modern Developments in Pulverised Coal Firing," by R. Jackson.

The Russian Copper Syndicate, Limited, 3, London Wall Buildings, London, E.C.2, is being wound up voluntarily. Mr. H. H. Mason is the liquidator.

The Material used for Piston-Heads of Large Diesel Engines.*

By Dr. Paul Wolff, Kiel-Gaarden.

It is very gratifying to note that the production of "improved" grey cast iron is gradually increasing in extent in recent years; and by using high-grade iron of this kind foundries are recovering a great deal of the ground they formerly lost. Unfortunately, however, many foundries are precluded by the claims of the patentees from producing a special cast iron by one or other of the recognised modern processes, or they have not the financial means of installing an electric furnace or an oil-fired reverberatory furnace, a powdered-fuel-fired drum furnace, etc., for producing their "quality" grey iron. It is the object of the present Paper to show how it is possible, even without using the above-mentioned processes, and by properly calculating and observing the charge in the furnace and exerting a constant and careful check on the quantity of coke, blast volumes, blast pressures, etc., to produce in the cupola a cast iron which, at least for certain purposes, is quite equal to a special cast iron or an "improved" grey iron produced by the patented processes.†

Casting.

The particular value of the following notes is probably that the tests to which they refer are not laboratory tests nor foundry tests carried out with small amounts of metal for the special purpose at which we are aiming; but they constitute data relating to castings made on a large scale for marine Diesel engines.

The melts in question were made in small and comparatively low cupolas of 3.4 to 4 tons per hour throughput. The furnaces were actually Greiner-Erpf furnaces which it was intended to scrap, and which had been modified in several respects in the course of years. *Inter alia*, there was only one row of tuyeres. All the data and figures given below were obtained from piston-heads for large marine-type Diesel engines, as shown in Fig. 1. The piston-heads were cast hot, with ring risers and two risers for "feeding" the metal. The latter were omitted in later castings, and the ring riser raised still higher. The piston heads were allowed to remain in the moulds for at least four days and nights, so as to cool slowly. Before the castings were poured, the structure of each tapping was tested by wedge samples and by quenching specimens cast in a chill-mould.[1]

Fracture Examination.

The following extensive investigations were really suggested from outside, due to the rejection of a few heavy piston-heads, in which white slaggy or sandy places were found during the machining operations, *i.e.*, when turning off the inside surface cast upwards. An absolutely pure metallic surface was called for in connection with the machining of the heads, which had to be machined all over, including the inside cooling spaces. The fracture of all piston-heads broken up to ascertain this exhibited a perfectly uniform, fine-grained close and at the same time serrated structure, both in the region of the casting skin and also in the interior of the fractured surface and of the side walls. This serrated structure pointed to a pronouncedly molecular cohesion, resembling, in this respect, the fracture of well-annealed cast steel.

It should be noted that the piston-heads of these and similar large marine Diesel-engine pistons have proved extremely satisfactory in service, and that, in spite of their large dimensions, the Diesel piston-heads did not crack. Extensive examination of the broken-up piston-heads confirmed the excellent quality of the castings, especially when it is remembered that all the samples were taken from the inside of the sections irrespective of how breakage occurred. When judging the results, it should also be remembered that the heavy castings had unfortunately already been subjected to a rough breaking-up process in the drop hammer, thus impairing the quality of the specimens taken from them.

The examination covered analysis, cold tensile and elevated temperature tensile tests (the latter at various temperatures), with various kinds of pre-treatment, transverse tests, Brinell tests, repeated impact tests, notch-impact tests, tests for "growth" and microscopical examinations. All the specimens required for these tests were taken from the inside of pieces of the rejected and broken-up piston-heads.

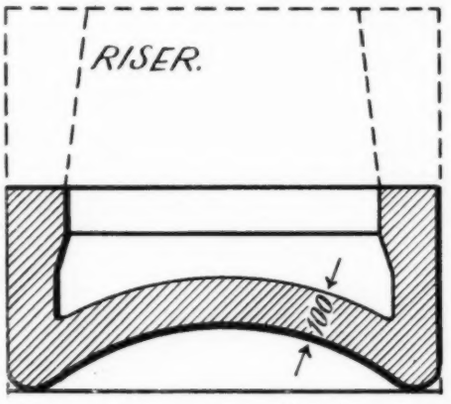

Fig. 1.—Type of Piston-Head used for the Investigations.

Tensile Tests.

The strength figures given along with the analyses in Table I represent the mean readings from three tests; and they show that these figures come within or on the limits of the Ge. 26.91 cast iron as specified in German Standards Specification No. 1691. In Table II are given further test results from the piston-head No. 1 of Table I. This specimen was used for the further tests in Table II and for the high-temperature tensile tests in Table III, as there were still a fairly large number of pieces from this piston-head from which it was possible to take a large number of test specimens. Of the other piston-heads, only one broken piece was available, and this was used for purposes of analysis and for the tensile bar. This will also explain how the tests in Table II and III were made, with the piston-head showing apparently the lowest strength.

It is possible to compare the quality of these piston-heads with those made by the newer and recognised methods by referring to the "Summarised Report of the Literature up to the End of 1927," given by Dr. Jungbluth in his Paper on "High-Quality Cast Iron."[2] In this Paper data are frequently given as to the strengths obtained from specimens cut from castings in a similar way to those obtained in this Paper. The first two of the following items relate to "perlit" iron, the middle one to Krupps "Star" cast iron, and the last to Emmel iron.

McRae Smith[3] gives tensile strengths of 18 to 17.13 tons/sq. in. for specimens taken from the casting. For specimens cut from the castings Young[4] gives figures of 16.75 to 13 tons/sq. in. and 13.95 to 15.85 tons/sq. in. respectively for iron containing 0.4 per cent. silicon and 0.8 per cent. silicon, the wall thicknesses of the castings from which the specimens were cut varying between 1 to 6 in.

Kleiber[5] was able to get 15.86 tons/sq. in. with "Star" cast iron on castings of 4-in. section. Emmel[6] also obtained 15.86 tons sq. in. for his high-quality low-carbon cast iron in specimens cut from a 4-in. section. Jungbluth, however, mentions that Kleiber's and Emmel's figures show wide divergences.

Impact Tests.

The figures given in Table II for deflection, repeated and notch-impact tests and for the growth of cast iron also exceed the published figures for specimens obtained from high-quality cast iron, although, before the results can be compared, they must, in part, be recalculated (this applies to the results of Hammerrann, Young, M. Buffet and A. Roeder).

As regards the figures for repeated impact tests, although there is none available from specimens cut out of the castings, we ought specially to mention Young's figures, as his tests were carried out under the conditions obtaining in Germany, *viz.*, weight of tup 9.2 lbs., height of impact 0.4 in., and specimens with round notch, and are consequently absolutely comparable. The impact tester used for testing the piston-heads was a Krupp dual-type repeated-impact testing machine.

Young's Perlit iron stood up to 1,344 to 1,829 blows, and on many occasions the iron probably stood up to 3,000 to 4,000 blows. Now compare this with Table II, showing 1,851 to 3,440 blows for the cut-out piston-head test-pieces.

Table I.

Piston-head. No.	Analysis.						Tensile strength. T./sq. in.	Brinell Hardness.
	T. C.	Gr. C	Si	Mn	P	S		
1	2.98	2.32	0.93	0.66	0.20	0.122	15.79	185
2	3.16	2.30	0.81	0.70	0.18	0.125	16.55	179
3	3.21	2.30	0.92	0.68	0.21	0.115	16.24	192
4	3.06	2.30	0.77	0.71	0.20	0.130	16.55	187
5	3.20	Not determined.	0.80	0.62	0.18	0.104	18.52	187
6	3.22	Not determined.	0.76	0.56	0.18	0.114	16.30	187
			Means				16.68	186

Hot Strength of Piston-Heads.

In accordance with the purpose for which these heads are used, the properties of the material at

* Translated from "Die Giesserei," February 8, 1929.

† "Die Giesserei," No. 20, May 6, 1928: High Quality Cast Iron. by Dr. Jungbluth.

1 Dr. -Ing. Wolff: "Prüfverfahren von Gusseisen." Stahl und Eisen, No. 17, April 29, 1926.

2 "Die Giesserei," Foundry Trade Journal, July 1, 1926.

3 "Die Giesserei," Foundry Trade Journal, July 1, 1926.

4 *Ibid.* Foundry Trade Journal, August 5, 1926.

5 "Die Giesserei," 1927, p. 465 and P. Kleiber: "Ueber den Kruppschen Sternguss" (on Krupp's Star Iron), Kruppsche Monatshefte, 8, 1927, pp. 110-116.

6 "Die Giesserei," 1927, p. 465.

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normal temperatures have not such a vital or decisive bearing on the quality as the physical behaviour at higher and varying temperatures—*i.e.*, what is termed the "hot strength" of the material. In the writer's opinion, many foundries make a mistake when they aim at obtaining the maximum tensile and transverse strengths at *normal* temperature in parts of Diesel engines exposed to varying and high temperatures. The same remark applies, of course, to gas engines and steam engines running on highly superheated steam. In their endeavours to get the maximum possible strength figures at normal temperature, many foundries turn out many defective castings for the parts of Diesel engines involved. The inevitable consequences are cracked cylinder-covers, pistons, exhaust-valves, and valve-stems. The figures given in Table III point to a very high structural stability at higher temperatures. Whereas, at a tensile-test-temperature of 400 deg. C., the figures almost attain those for Ge. 26.91 specification and none is lower than the figures at normal room temperature, the figures are not lower at a tensile-test-temperature of 400 deg. C. after the material had been heated seven times to 600 deg. C. and on each occasion allowed to cool down for nine hours overnight.

At test-temperatures of 500 deg. C., the bars being treated in precisely the same way as the tests just mentioned and where the material was heated seven times to 600 deg. C., the strength does not drop appreciably and is still well above that for Ge. 18.91. It is true that the tensile strength falls on the average to 9.12 tons/sq. in. at 600 deg. C.

The writer has been unable to find comparative figures with test-pieces cut from castings. Curve 14, "Hot Strength of Various Types of Cast Iron," in Jungbluth's Paper, and Fig. 21 in Kleiber's Paper, cannot be used for purposes of comparison, because these particular figures refer to separately-cast and very high-quality test-bars. Expressed in terms of percentage, the drop in strength from room temperature to 500 deg. C.—no higher temperatures are involved in the case of Diesel engine pistons*—in Fig. 21, referring to "Star" cast iron ready for delivery, is 9 per cent., and in Curve 14, referring to iron ready for delivery, it is above 15 per cent., whereas the drop in strength for piston iron mentioned in this Paper as ready for delivery and tested at a temperature of 500 deg. C., is barely 9 per cent., according to Table III. From the point of view of percentage drop in strength—in this case, therefore, from the standpoint of the internal value of the material at higher temperatures—the particular material forming the subject of this article is extremely strong compared with the types of cast iron mentioned.

* Dr.-Ing. W. Riehn: Temperature Measurements on Oil Engine Pistons. Ztsch. des Vereins deutscher Ingenieure, August 27, 1921.

Table II.—*Further Test Results obtained from Piston-Head* 1 *(Table I).*

Specimen.	Transverse test. Dimensions. In.	Transverse strength. Tons/in.²	Deflection. In.	Continuous impact test. (Round notch.) Specimen.	Number of blows.	Notch impact test. Specimen.	Specific energy of impact. Mkg./cm.²
B_2 ..	0.8 dia. × 8 long	34.90	0.12	D_1	3,440	K_2 (= 4 x)	28.8
B_3 ..	„ „	37.70	0.16	D_2	1,851	K_{2_1} (= 2 x)	35.5
B_5 ..	„ „	Specimen	cracked	D_3	2,264	K_6 (= 4 x)$_1$	29.3
$B_6{}^1$ ..	„ „	33.64	0.12	D_5	1,968	K_9 (= 2 x)	30.0
Mean ..		35.22	0.13		2,381		30.9

Analyses.

In view of the general results obtained, a few tests were carried out with piston-heads of a different composition with a view to ascertaining the effect of increased silicon on the quality of the castings produced. The analyses were as follows:—

First Experimental Head: C, 3.15; Si, 1.24; Mn, 0.63; S, 0.09; and P, 0.30 per cent.

Second Experimental Head: C, 3.14; Si, 1.50; Mn, 0.62; S, 0.086; and P, 0.22 per cent.

The strength and Brinell hardness of the specimens machined out of the castings were round about 13.95 tons/sq. in. and 176 (Brinell) respectively; the strength is therefore approximately 20 per cent. lower than the average of Table I. The photographs—not reproduced here—however, exhibit at 500 magnification an extraordinary deterioration in quality, so that the structure becomes coarsely pearlitic and interspersed with pronounced veins of graphite. The photomicrograph of the material containing 1.50 per cent. silicon, in particular, shows that this cast iron would not be suitable for highly-stressed piston heads.

Table III.—*Elevated Temperature Tensile Tests. Initial Material. Piston-Head* 1 *(Table I), the Tensile Strength of which* = 15.72 *Tons sq. in.*

Tensile test temperature, 400 deg. C. Heated once. Tons/sq. in.	Tensile test temperature, 400 deg. C. Previously heated 7 × 60 hours to 600 deg. C. Tons/sq. in.	Tensile test temperature, 500 deg. C. Heated once. Tons/sq. in.	Tensile test temperature, 500 deg. C. Previously heated 7 × 60 hours to 600 deg. C. Tons/sq. in.	Tensile test temperature, 550 deg. C. Heated once. Tensile strength. Tons/sq. in.	Tensile test temperature, 600 deg. C. Heated once. Tensile strength. Tons/sq. in.	Increase in volume after heating 20 hours at 600 deg. C. Round bars 3½ in. × 0.8 in. diameter. Length. Per cent.	Diameter. Per cent.
15.19	15.16	15.29	13.51	13.50	9.18	0.11	0.00
16.36	15.60	14.71	13.70	13.70	9.70	0.13	0.00
—	15.22	14.20	—	—	—	—	—
15.77	15.32	14.78	13.10	13.13	9.44	0.12	0.00

Messrs. A. G. Kidston & Company, Limited, iron and steel merchants and exporters, are removing on Monday next, May 20, from 93, West George Street to 40, St. Vincent Place, Glasgow, C.1.

A conference has been held in London between representatives of the Shipbuilding Employers' Federation and of the shipyard trade unions to discuss the application of the men for an increase in wages of 5s. a week to time workers and an equivalent increase to piece-workers. The discussion lasted two hours, and at the close it was announced that another conference would be arranged after the employers' association had consulted its constituents. The men's representatives claimed that there had been sufficient improvement in the state of the shipbuilding industry to warrant an increase in wages.

A Freak Waster Casting.

By H. Lewin.

Whilst the writer was general manager of a light-castings foundry in India, the casting shown in Fig. 1 was turned out of a mould when stripping was in progress. The casting was moulded from a pattern of a rainwater head of special design, to suit a rectangular section downspout.

The photograph was taken of the face of the casting which was at the bottom of the mould, and one's first idea would naturally be that the green-sand core had collapsed, and caused the casting to be a waster. This to a certain extent was true, but careful observation in the foundry of somewhat similar phenomena enabled the following diagnosis to be made.

An insect, in appearance something like our common wasp, but twice as big and with wider bands of colour around its body, would fly across the foundry floor. Sometimes it would alight on a soft sand heap, and burrow a way into it. In this instance the insect had alighted on a mould with the green-sand core in position, and then wandered down between the mould and the core. Arriving on the bottom side of the core, it had commenced burrowing, and the core had fallen away, the sand dropping to the bottom of the mould. After meandering about in an apparently aimless fashion, the insect eventually decided to burrow into the bottom edge of the mould in a downward direction.

Fig. 1.—The Freak Waster.

Nothing of this being visible from the outside, the top part had been put into position and the mould closed. Later, when the mould was poured, the metal also ran down the hole after the insect and destroyed it, causing the casting to apparently have a "riser" in a downward direction as shown on the photograph by the piece of metal slightly thicker than a lead pencil being held in position, where it had broken off, whilst the photograph was taken.

Usually wasters in the foundry are traceable to either faulty workmanship or faulty metal, but when an outside agent of this description takes an interest in the foundry products, one realises more than ever the truth of the saying: "The foundry is the Devil's playground."

Experiments with steel sleepers which the Great Western Railway Company has been making on a section of track in Monmouthshire have given satisfactory results, it is reported. The sleepers used were made by Messrs. Guest, Keen & Nettlefolds, Limited, at Dowlais.

High-Quality Cast Steel containing Chromium and Nickel.

Experiments have been made by V. Zsak* on the influence of heat-treatment upon the mechanical properties and the primary structure of cast steel containing chromium and nickel. The heats were made in a basic-lined Heroult electric-furnace. The composition aimed at was that of steel, VCN35, which is widely used in the automobile industry. The actual compositions of the different heats are recorded in Table I. The as-cast structure of steel is greatly influenced by the pouring temperature. When it is high the number crystallisation nuclei is small, but the crystallisation velocity is very great; therefore, very large crystals are formed, growing perpendicularly to the cooling surfaces. The solidified samples show a dendritic or transcrystalline structure. However, when the pouring temperature is low the number of crystallisation nuclei increases and the crystallisation velocity decreases; in this case the solidified samples show a globular structure. The heats Nos. 1 and 2 were poured at high temperature, the heats Nos. 3 to 5 at low temperature.

From the different heats test-bars, according to Fig. 1 (measures given in millimetres), were cast into dry-sand moulds; after cooling, which took about 16 hours, the gates were removed and the bars cut into four pieces, as shown in the figure. From the heat-treated pieces test-samples can be seen from Fig. 2, where the original bars near the skin; whereas those marked with ° are associated with samples cut from the interior. The former values are always higher because of the chilling effect of the mould, which results in a denser structure. The microscopic examination showed that the decomposition of the accicular primary structure begins at 650 deg. C.; at the same time some troostite appears. After annealing at 820 to 1,000 deg. C. pearlite is formed containing more or less sorbite. At temperatures above 1,000 deg. C. the ferrite segregates along the grain boundaries.

(b) *Samples with Globular Fractures.*—Here the test-values are remarkably lower; this is especially the case with the elongation, contraction of area and impact strength. The ratio of the yield point to ultimate tensile strength is somewhat higher (60 to 65 per cent.). After annealing at temperatures above 1,000 deg. C.

TABLE I.

Heat No.	C	Si	Mn	S	P	Cr	Ni	Fracture.
1	0.33	0.15	0.65	0.017	0.026	0.65	3.19	Transcrystalline.
2	0.31	0.22	0.57	0.014	0.022	0.72	3.17	„
3	0.33	0.21	0.62	0.015	0.029	0.65	3.20	Globular.
4	0.31	0.22	0.61	0.016	0.024	0.68	3.19	„
5	0.33	0.17	0.63	0.014	0.033	0.68	3.40	„

TABLE II.

Sample No.	Heat No.	Annealing. Temp. Deg. C.	Annealing. Period. Hours.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per cent.	R. A. Per cent.	Impact. Sample.	Str. Ft.-lbs.	Brinell No.
1	1	untreated	untreated	—	35.3	1	—	i	6.5	302
								d	4.34	
2	2	„	„	—	36.3	1	—	i	5.78	302
								d	5.06	
3	1	650	2	—	34.0	—	—	i	3.61	255
								d	3.61	
4	2	650	2	—	39.7	4	—	i	7.23	241
								d	12.3	
5	1	820	2	30.6	49.7	15	34.1	m *	30.4	217
								m °	26.1	
6	2	820	2	—	—	—	—	m *	27.5	—
								m °	23.9	
7	2	820	6	—	—	—	—	m *	18.8	—
								m °	17.35	
8	1	900	2	30.6	49.8	15	38	m *	41.2	217
								m °	26.7	
9	1	1,000	2	28.6	48.9	16.5	41.5	m *	22.4	217
								m °	19.5	
10	2	1,000	2	27.3	47.1	20	45	m *	30.4	217
								m °	14.45	
11	1	1,000	6	26.6	49.2	16	40.7	m *	18.8	217
								m °	15.2	
12	1	1,150	2	—	51.2	4	19.8	m *	11.57	255
								m °	7.95	
13	2	1,150	2	30.6	50.4	8	7.3	m *	5.78	241
								i °	8.67	

† Per square centimetre.

TABLE III.

Sample No.	Heat No.	Quenching temperature. Deg. C.	Annealing temperature. Deg. C.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per cent.	R. A. Per cent.	Impact. Sample.	Str. Ft.-lbs.	Brinell No.
29	1	820	600	48.2	56.9	14.5	36	—	—	277
30	2	820	600	45.4	53.9	12.6	29.7	m *	68.1	269
								m °	62.9	
31	2	820	600	46.3	52.3	10	46.4	m *	72.3	286
								m °	56.4	
32	2	900	600	—	—	—	—	m *	53.6	—
								m °	43.4	
33	2	900	600	—	—	—	—	m *	44.8	—
								m °	57.8	
34	2	1,000	600	—	—	—	—	m *	65.1	—
								m °	57.2	
35	2	1,150	600	—	—	—	—	m *	81.1	—
								m °	79.6	

* "Die Giesserei," 1929, No. 9, pp. 193/205.

" d " means sample of the Germany Society for Testing Materials, " i " sample of the International Society, and " m " Mesnager sample (used in France); in the following tables the same marks are used. In the majority of cases the Mesnager sample was tested.

The heat-treatment was made in electrically-heated furnaces; the following methods were investigated:— (I) Plain annealing. (II) Quenching and annealing. (III) Special quenching and annealing.

I.—Plain Annealing.

(a) *Samples with Transcrystalline Fractures.*—The samples were heated to 650, 820, 900, 1,000 and 1,150 deg. C., respectively, kept at these temperatures for some time and then cooled in the furnace. From the fracture it could be seen that after annealing at 900 deg. C. the refining

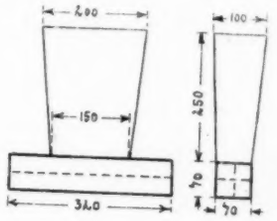

Fig. 1.

of the grain was completed; the fine grain-size was still intact after annealing at 1,000 deg. C. From this it may be concluded that steel containing nickel and chromium is not very sensitive to heat-treatment. The fractures of the samples annealed at 1,150 deg. C. were coarse and bright. The test-values recorded in Table II show that annealing at 650 deg. C. does not improve the mechanical properties; this is the more surprising, as with forged samples annealing at from 600 to 650 deg. C. gives the best values of elongation and contraction of area. The best values were obtained after annealing at 900 deg. C. The ratio yield-point to ultimate tensile strength is 58 to 62 per cent. (The yield-point is the stress where plastic-deformation occurs.) The impact values, marked with *, were found with samples taken from

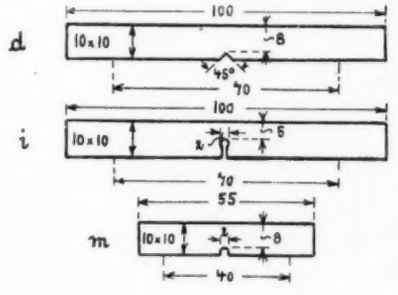

Fig. 2.

no ferrite is to be seen along the grain boundaries.

II.—Quenching and Annealing.

The samples were heated to different temperatures, kept there for two hours, and then quenched in oil; the quenched samples were annealed at 600 deg. C. for one hour and cooled in oil or in the air. Quenching results in producing a very homogeneous, hard texture consisting of martensite; by annealing, the martensite is converted into sorbite, which shows the best mechanical properties. From the test values of the samples with transcrystalline fracture recorded in Table III, it can be seen that the yield point and the impact strength are remarkably improved; a slight increase is also to be found with the ultimate tensile strength. The ratio of yield point to tensile strength is 83 to 90 per cent. The test values for elongation, contraction of area, and impact strength of the samples with globular fractures were considerably lower.

III.—Special Quenching and Annealing.

In the foregoing experiments it was found that quenching from a higher temperature than 820 deg. C. resulted in producing hardening-cracks. Only the small impact test-samples could be prepared from the quenched bars. From the good impact-values, however, which were found with both the transcrystalline and globular samples one could assume that quenching from high temperatures might further improve the mechanical properties. Therefore the following method was adopted: the samples were kept at the high temperature for a definite period, quickly cooled in the air to about 820 deg. C., and then quenched in oil; the quenched samples were annealed at 600 deg. C. and cooled in oil. From the test-values recorded in Table IV it can be seen that the properties of the transcrystalline sample (No. 47) are not materially improved by this quenching method. However, the samples with globular fracture (Nos. 48 to 56) show values of elongation, contraction of area, and impact strength which are not inferior to those of the transcrystalline sample. Besides this, the little difference of the test-values indicates that the structure is very homogeneous. The ratio of yield point to tensile strength is 86 to 88 per cent. By quenching from 1,050 deg. C. the impact strength is further improved, but the elongation and contraction of area are diminished.

Table IV.

Sample No.	Heat No.	Sample kept at deg. C.	Sample kept for hours.	Annealing period. Hours.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. Per cent.	R. A. Per cent.	Impact str. Sample.	Impact str. Ft.-lbs.	Brinell No.
47	1	1,000	2	1	47.4	55.4	12.5	36	m *	68.8	269
									m °	58.6	
48	4	1,000	2	1	47.8	55.4	12	28.5	m *	60.1	255
									m °	44.8	
49	5	1,000	2	1	46.8	55.2	14.5	32.5	m *	36.2	277
									m °	34.0	
50	5	1,000	4	2	47.2	55.1	11	22	m	30.4	255
									m	29.7	
51	4	1,000	6	2	47.3	54.6	12	32	m	44.2	269
									m	36.9	
52	5	1,000	6	2	45.8	54.3	11.6	19	—	—	255
53	4	1,050	2	1	47.6	55.2	10	18	m *	70.2	286
									m °	50.6	
54	5	1,050	2	1	48.8	56.2	10	28	—	—	286
55	5	1,050	4	2	49.2	56.2	9	18	m *	52.8	269
									m °	34.0	
56	4	1,050	6	2	—	55.4	10	24	m *	72.3	269
									m °	68.1	

Messrs. Thomas W. Ward, Limited, Sheffield, have purchased the old Lambeth suspension bridge from Messrs. Dorman, Long & Company, Limited, who are building a new structure across the Thames above Westminster. The old bridge, which is a steel structure, will be broken up and sold for scrap.

Book Review.

Blast Furnace Practice.—By Fred Clements. Vol. I, 538 pp. ill. General Principles; Source, Preparation and Handling of Raw Materials. Published by Ernest Benn, Limited, of Bouverie House, Fleet Street, London, E.C.4. 1929. Price 63s. net.

There are many outstanding works among the literature of British metallurgy, but it is an undoubted fact that during the past ten years American and German readers have had access to more modern works than we in this country. In view of the vital importance of good text-books, both to operators and to students, it is to be hoped that worthy English successors will be found to the older volumes.

The present book is the first of three volumes, and we may say at once that if the remaining two are equal to this one British blast-furnace men and metallurgists will have access to a work that will be the most complete of its kind published in any language. In character it is almost encyclopædic, illustrated with a wealth of photographs and diagrams, and it must represent the work and experience of a lifetime. Very cordial congratulations are due to the author on his achievement, while the publishers also are deserving of commendation for the way in which the book has been produced.

Blast-furnace practice is of enormous interest to the founder and the foundry metallurgist, for it is their task to make good castings from the material supplied by the blast furnace, a task which, in the opinion of many of them, is becoming increasingly difficult. The use of the pig is very considerably affected by its composition, as well as by its size and the methods and conditions of casting (*i.e.*, temperature, sand- or chill-cast, and so on) and modern research is tending to show that the physical characteristics of iron (such, for instance, as an all-important foundry property like shrinkage) tend to persist through the melting in the cupola.

The second chapter is of the most direct interest to the founder, for it deals with the metallurgical properties of pig-iron. Some would be inclined to consider such a chapter out of place in a work already so vast in its scope, but we sympathise with the author's desire for completeness.

There are several topics of interest to founders on which his views are valuable. On fracture, he says, "the classification of irons by fracture, while being simple and of small cost, is of little actual value as a guide to the character of the iron and its suitability for certain processes. Similarly, the analysis of iron is not, of itself, sufficient guide unless a careful determination is made of the proportions of combined carbon and graphite, because the proportion of combined carbon has a marked influence on the fusibility of the iron in re-melting. This is too long and costly a process for common uses, and in general practice a combination of the two methods—examination of the fracture, and analysis for the common impurities—is necessary for the accurate classification of the various brands of iron made. In general, especially in hematite irons, more emphasis is now laid upon the analysis of the iron than upon its fracture."

On cold-blast iron, he says, "if the iron is made at a low temperature in the blast furnace, as often occurs in cold-blast iron, the carbon content may be below 4.3 per cent., thus appearing to accept the theory of the hypoeutectic character of cold-blast iron, while on cold-blast and hot-blast irons," he says, "the old cold-blast iron has characteristics, both in closeness of grain and uniformity of structure, which are lacking in material produced by modern hot-blast methods. An adequate theory satisfactorily to explain this difference has still to be formulated, but the fact is beyond question, as anyone who has had experience in the breaking up of the machines built during that period can testify."

On the influence of scrap, he suggests that from similarity of analyses of irons made with varying scrap burdens, the question of the use of scrap is a purely economic one, ignoring possible physical differences between all-mine and scrap-bearing irons, although the author tacitly admits such differences between hot- and cold-blast irons.

Chemical, physical, and thermal principles of blast-furnace operation are dealt with at length, and there is an exhaustive treatment of the nature and occurrence of iron-ore deposits and their economic importance. Mining and preparation is considered, together with sintering, calcining, drying and other preparatory treatment. The production of blast-furnace coke has a chapter to itself, and the air-blast is treated in another. Much that is touched upon in these pages will have an obvious interest for founders in connection with the cupola. The remaining volumes will deal with design and operation, and those engaged in the industry will anticipate them eagerly.

J. G. P.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for March, report that steel production in March still further improved and, at 859,900 tons, compared with 774,900 tons in February and 793,300 tons in March, 1928: production was thus higher than in any month since May, 1927. Pig-iron production, though handicapped to some extent by the shortage of coke, amounted to 590,500 tons compared with 519,600 tons in February and 592,600 tons in March, 1928.

Returns received from 135 firms employing 86,868 workpeople at the end of March showed an increase of 1,846 compared with February, and an increase of 761 compared with March, 1928. According to returns from 137 firms employing 116,067 workpeople the average weekly earnings per head in February amounted to £3 2s. 7d. compared with £3 2s. in January and £2 19s. in December.

A contract for the steelwork for a large new office block in Millbank, London, has been placed by Anglo-Properties, Limited, Lord Melchett's finance corporation, with Messrs. Dorman, Long & Company, Limited, of Middlesbrough. The same company has secured a contract for the supply of the steel for the new "Olympia," and also one for the steelwork for Messrs. W. Gamage & Company's new West-End store, the construction of which has just begun in Oxford Street. The steel for these three contracts, it is stated, is valued at over £500,000.

Cupola Melting Losses; Constant Carbon Content and Pyrometric Control.

After the Annual Meeting of the London Section of the Institute of British Foundrymen, the Chairman (Mr. J. W. Gardom) asked Mr. H. J. Young to open a discussion on any problem of general foundry interest.

Cupola Melting-Losses.

Mr. Horace J. Young chose the extent of the melting losses in the cupola. He had always thought, he said, that the loss was about 5 or 6 per cent., but in one works he had found a 14-per-cent. loss on a 20-ton melt and a 12½-per-cent. loss on a 10-ton melt. In another works he had found a 15-per-cent. loss on a 5-ton melt. He asked for the experience of other members in this connection.

Mr. V. C. Faulkner (Past-President of the Institute and of the Branch) asked how much sand was in the pig-iron used.

Mr. Young replied that in one of the works in question the pigs had been newly delivered and were very sandy, but in the other works the pigs used had been standing for a long time and had adhering but little sand. In any case, he did not think that sand would make a difference of more than 1 per cent., and it seemed likely that a figure of 11 per cent. would more nearly represent the actual melting loss of normal practice than does a figure of 5½ per cent.

The Chairman said that if one compared the amount of pig-iron bought and the amount of castings sold each year, making proper allowance for scrap, one would find that the loss was about 12 per cent. His firm was in an exceptionally good position for judging that, because a refined pig was used, containing no sand, and the whole of the scrap was re-melted. The extent of the melting loss had surprised him, but he had been unable to arrive at any explanation.

Mr. Hodgkiss recalled a statement made to him by a foundryman some ten years ago, to the effect that his melting loss was as high as 20 per cent. over a considerable period. Though he had instituted inquiries into the matter, he had not been able to discover how the loss had occurred.

Total Carbon Content a Function of the Cupola.

Mr. Faulkner asked whether it was the general experience that the percentage of total carbon in a metal depended upon the particular cupola in which it was melted, and that the percentage would remain constant even though the conditions were altered (except blast variation) within reasonable limits. A tremendous amount of work had been done in this connection in Germany. The metallurgists there had varied, within reason, the composition of the metal charged and had kept other conditions standard, but had found that the percentage of total carbon in the resultant metal was the same in each case. If they added a large amount of steel, the percentage of total carbon became higher instead of lower; if the phosphorus content were materially increased, the total carbon content became higher; and the manganese content also slightly affected the total carbon percentage. They had been able to postulate the idea, however, that though one might vary the working of any one particular cupola, except as to blast conditions, and vary the mixtures within reason, the total carbon content of the resultant metal was generally the same.

Dr. A. B. Everest said his impression was that if one kept the cupola working under constant conditions, the total carbon content of the resultant metal was a function of the cupola rather than of the total carbon calculated in the charge. With a given coke-ratio and blast-pressure, a mixture with a total carbon content calculated at about 2.8 per cent. going in at the charging door would show a total carbon content in the resultant metal of, say, 3.4 per cent.; if, working under the same cupola conditions, one used a mixture having a total carbon content calculated at about 3.6 per cent., the total carbon content of the resultant metal would tend to be again about 3.4 per cent. He believed, however, that by altering the blast-pressure one would alter the final composition especially of carbon.

Mr. Horace J. Young said that when working with hematite irons of high total carbon content—sometimes as high as 4.5 per cent.—one would notice a loss in carbon in a normal mixture because the hematite irons seemed to discharge some of their carbon. In the case of phosphoric irons, containing 3.4 to 3.8 per cent. total carbon, that loss by discharge did not occur. One could not calculate final total carbon without having experimented with the cupola under the conditions it was proposed to work. There was no doubt that if one altered the blast of the cupola, one altered the amount of total carbon. In one foundry, of large weekly output, the total carbon of all their cast irons was consistent at about 3.9 per cent. All sorts of castings were being made, and the better ones had a tensile strength of from 18 to 20 tons per sq. in., though the castings were leaky when subjected to hydraulic tests. The silicon contents varied from 1 to 2½ per cent. He could not agree with the suggestion that all cupolas were alike. The results obtained depended upon (1) how a cupola was worked, (2) the composition of the charge, and (3) the nature of that charge.

Use of Pyrometers in Foundries.

Mr. J. Ferdinand Kayser asked for the opinions of members as to the use of pyrometers in foundries. Some years ago he had thought that there was no better way of controlling casting temperature than by means of a pyrometer, and he had even invented one, but since that time he had come to the conclusion that pyrometric control was useless in the foundry. He considered it far easier to judge casting temperatures by workshop methods, which did not depend on colour effect than by the use of a pyrometer.

The Chairman asked if Mr. Kayser were referring to iron?

Mr. Kayser replied that he was referring to all metals, with the exception of brasses and similar alloys, in which the surface appearance was governed by the burning of zinc or some similar metal.

Dr. A. B. Everest said he had not yet found any satisfactory method of measuring casting temperature in the ironfoundry. One could get a reasonably accurate measure of the temperature of the metal leaving the cupola if one used a proper instrument and if one were trained in the use of that instrument, but he did not know of any standardised method capable of being used by anybody who was not accustomed to its use. At one works at which pyrometers were used to measure the temperature of the metal leaving the cupola, he had been told that the temperature was about 1,100 deg., but he had found that actually it was over 1,300 deg., and that for months the temperatures recorded were 200 deg. below the actual temperatures. It appeared to be practically useless to try to measure casting temperatures in a foundry. A good optical pyrometer could be used to measure the temperature of the iron leaving the cupola, but there was still needed a really practical method of measuring casting temperature on the foundry floor.

Mr. A. S. Beech recalled a conversation he had had with a man who had been working a cupola for years. This man had had no idea of the temperature of the metal coming down the spout, but when he had seen the fumes coming off the metal he had been able always to judge the temperature reasonably accurately. There was no pyrometer, in the opinion of the speaker, which would give consistent and accurate readings of the temperature of the metal leaving the cupola.

Mr. Kayser suggested that there was no definite temperature which could be regarded as the correct casting temperature for any type of metal. For a particular batch one knew the temperature which gave good results, but if one obtained raw material from a new source it was necessary to alter the casting temperature in order to obtain good results. In the steel industry that was particularly marked. Steel castings made from base metal usually had to be cast at a much higher temperature than steel castings made from re-melted scrap; the effect upon the refractories when melting base metal was much more severe than when re-melting scrap after the molten condition was reached, which indicated that more heat had to be pumped in. Except in the case of metals such as brasses, a skilled moulder or furnaceman could determine the casting temperature by appearance. If one placed a cold rod over the surface of the metal in the furnace and noted the chill effect, one could form an idea of the difference between the freezing-point temperature and the actual temperature of the metal in the furnace, and it was the excess temperature over the freezing-point temperature that one required to measure.

Pyrometers Essential in Bronze Foundries.

Mr. H. C. Dews said he was a great believer in the pyrometer, and that it was quite impossible, in a bronze foundry at any rate, to produce successful castings consistently without it. So far as he knew, there was not a pyrometer on the market which would measure accurately the temperature of cast iron. Ironfounders could not claim that a pyrometer would be of no use in the iron foundry, therefore, but when a pyrometer was evolved which would measure accurately the temperature of molten cast iron, and when that pyrometer was used in the iron foundry, they would open their eyes and appreciate its value. A type of pyrometer had been evolved which was more or less successful in a bronze foundry. As an instance where a pyrometer was essential, he mentioned making castings in a particular type of phosphor bronze, which commenced to freeze at 995 deg. C. The correct casting temperature for one particular casting in this alloy was 1,020 deg. C., and if it were cast below 1,015 or above 1,025 deg. C., it was not successful. If a practical man could judge the temperature of phosphor-bronze to within 5 deg. without the aid of a pyrometer, he would take off his hat to him. Similar remarks applied to brass-founding, and there a pyrometer was also necessary. In the case of cast iron the casting temperature was perhaps not so important, and the ironfounders had not felt the need for a pyrometer to the same extent.

Mr. A. Herring said he supposed that at the Mint a fair amount of phosphor-bronze was used, but the pyrometer did not see the pot from Monday morning until Saturday night.

Mr. Wesley Lambert (President-Elect of the Institute) disagreed emphatically with the suggestion that the pyrometer was useless, in so far as this suggestion referred to a brass or bronze foundry. One must have a considerable amount of pluck who would, for instance, attempt to cast, without the aid of a pyrometer, a large marine propeller weighing 25 or 30 tons, in manganese bronze, which incidentally is a very expensive metal. It was not so much a question of determining the actual casting temperature as of determining the superheat of the metal, as has been indicated by Mr. Kayser. If a foundry were properly run, with laboratory supervision, all pyrometers would be kept in a standardised condition. In all important work there should be a standard pyrometer available, so that if one had reason to believe that the pyrometer he was

using was not giving correct readings, use could be made of the standard pyrometer.

Mr. Horace J. Young said that in Diesel or other important work he would not accept his own or anyone else's opinion as to the temperature of the metal, but would need the help of a pyrometer. The pyrometer, in spite of its limitations, was as useful in the iron foundry as in the brass foundry.

Chairman's Summing-Up.

The Chairman (Mr. J. W. Gardom), summing up the discussion, emphasised the importance of the three matters discussed. The problem of melting losses was one in regard to which the practical man criticised the scientific man severely. We were all apt to talk scientifically about the amount of iron which went into the slag and the amount of oxidation that occurred. The practical man knew that he was losing more than could be accounted for by those factors; we failed to appreciate the amount of iron that went into the gutters round the roof. With regard to the control of carbon in the furnace, he expressed entire agreement with the view that, with standard working of the cupola, one obtained iron with practically a standard total-carbon content. He had melted 100 per cent. steel fairly successfully and had obtained a product containing 3.4 per cent. total carbon. One could control total carbon content more by variation of the blast than by any other factor, a soft blast giving a lower total carbon content. As to the use of pyrometers, he did not think anyone could doubt that a pyrometer was an aid to success in any foundry. Where castings of the same type were being cast in the same type of mould daily, the practical man of experience could cast them fairly successfully, but he did not think that such a man could change over from one type of casting to another and produce them so successfully as could a man who was accustomed to the use of the pyrometer as an aid to control.

At the conclusion of the discussion, a hearty vote of thanks was accorded Mr. Young, Mr. Faulkner and Mr. Kayser for having introduced the three subjects for discussion.

Industry's Need: Increased Price or Output.

In replying to the toast of the "Commercial Interests of Scotland" at the dinner of the Chartered Institute of Secretaries in Glasgow recently Mr. S. R. Beale, of Messrs. L. Sterne & Company, Limited, Crown Iron Works, Glasgow, and President of the Glasgow Chamber of Commerce, said that the present tendency towards improvement in trade was really due to the absence of external and internal disturbances. He thought they might fairly ask whoever might so confidently assume the reins of government within a month that, if they wanted the full credit out of the taxes they might impose, they had to give industry an increased price or an increased output, or they would not be able to squeeze another pip out of them, let alone any juice. Not only was it impossible for any benefit to accrue to a nation that taxed a business that was not making a profit, a point for which the present Government had not quite all the credit which it deserved, but it was also impossible for a business in that position to increase its contribution to improving the standard of living of its employees. One of the healthiest signs in the country to-day was the very sincere interest that all were taking in trying to promote a general improvement in the daily conditions of the less fortunate portion of their fellow-countrymen. He visualised the possibility that, given reasonable conditions and internal and external peace, they would be able once again to force themselves back into their old position of successful competition in the markets of the world.

The Influence of Copper upon Cast Iron.

After a brief summary of the literature dealing with the influence of copper upon cast iron C. Pfannenschmidt* reports upon experiments he made in this direction. Three test-bars were cast from ordinary cupola iron at about 1,420 to 1,440 deg. C.; after a definite quantity of molten copper had been added to the remainder of the melt, three other bars were cast. From the chemical analysis of the bars recorded in Table I it can be seen that, irrespective of the silicon content, the graphite is slightly increased when copper is present. In spite of this fact, the mechanical properties were improved, as can be seen from Fig. 1, where the tensile test data are illustrated. The Brinell hardness and the transverse strength were also improved. In further experiments the author investigated the corrosion resistance of the samples by dipping them into 1.0 per cent. acetic acid, 1.0 and 0.33 per cent. nitric acid, and tap water; in all cases an improvement of the corrosion resistance by copper could be stated.

Table I.

T.C.	Graphite.†		Si	Mn	S	P	Cu	Samples without copper.		
								T.C.	Graphite.†	
3.30	2.69	81.5	2.02	0.89	0.1	0.44	0.35	3.37	2.77	82.2
3.14	2.38	75.8	1.83	1.12	0.1	0.27	0.74	3.15	2.36	74.9
3.17	2.30	72.5	1.51	0.95	0.09	0.24	0.88	3.19	2.28	71.5
3.00	2.37	79.0	1.75	0.84	0.1	0.31	1.25	3.03	2.34	77.2
3.00	2.33	77.6	1.86	0.84	0.08	0.29	1.27	3.10	2.32	74.8
3.23	2.66	82.3	1.77	0.91	0.07	0.42	1.82	3.33	2.60	78.1

† In percentages of the total carbon content.

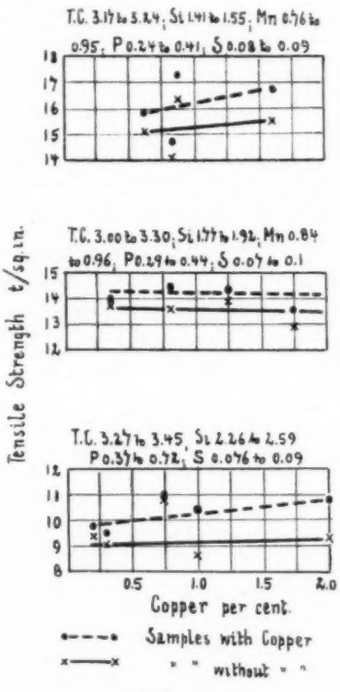
T.C. 3.17 to 3.24; Si 1.41 to 1.55; Mn 0.76 to 0.95; P 0.24 to 0.41; S 0.08 to 0.09
T.C. 3.00 to 3.30; Si 1.77 to 1.92; Mn 0.84 to 0.96; P 0.29 to 0.44; S 0.07 to 0.1
T.C. 3.27 to 3.45; Si 2.26 to 2.59 P 0.37 to 0.72; S 0.076 to 0.09
Tensile Strength t/sq in.
Copper per cent.
Samples with Copper
" " without " "

Fig. 1.

The steel twin-screw oil-tank motor-ship "Laurelwood," built to the order of Messrs. John I. Jacobs & Company, was launched from the Walker Shipyard of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, on May 9. The vessel is designed to carry 10,000 tons deadweight, and she will be propelled by two single-acting Diesel engines of the enclosed type working on the four-stroke cycle.

* "Die Giesserei," 1929 No. 8, pp. 179/82.

Institute of British Foundrymen.

The West Riding of Yorkshire Branch of the Institute of British Foundrymen held their annual meeting at the Technical College, Bradford, on April 27, under the chairmanship of Mr. W. G. Thornton (President). Before commencing the business of the meeting, the President said how pleased he was to be able to welcome Mr. S. W. Wise (Hon. Secretary) back again, after his long spell of illness.

The Secretary, in presenting the annual report, said he thought the Branch should be congratulated on the work it had done during the past year. Unfortunately, it was not possible to report an increase in membership, but the enthusiasm of the members had been unimpaired. All the meetings which had been scheduled had been held, and included a joint visit to the works of Messrs. Worthington Simpson, Limited, of Newark, with the East Midlands Branch. Tribute was paid to the hospitality which the Lancashire Branch had extended to the West Yorkshire Branch when a joint meeting was held at Manchester. A particularly enjoyable item on the syllabus was the Summer Outing to Fountains Abbey by the members and their lady friends. Unfortunately, the weather on that occasion was rather inclement, but the outing proved to be one of the most enjoyable functions the Branch had held. The Secretary also referred to the very successful meeting which was held on the occasion of the visit of Mr. S. H. Russell (President of the Institute), when the members toured the Engineering Departments of the Bradford Technical College. Arrangements had also been made for a visit to the works of the English Electric Company, Bradford, and to the foundry of Mr. W. G. Thornton (President). Mr. Wise said during the past year, owing to ill-health, he had had to pass a lot of the secretarial work on to other people, and it had been very pleasing to him to notice how willing everyone had been to do something for the welfare of the Branch. He would also like to take the opportunity of thanking all members for their kindness, and particularly wished to express thanks to Mr. Thornton and Mr. H. Forrest (Acting Secretary).

In moving a vote of thanks to the Secretary for his report, the President said his one aim was to do his best for the Branch.—The motion was seconded by Mr. H. Sayers (Leeds), and carried unanimously.

The following officers were elected for the ensuing year:—President, Mr. W. G. Thornton (Bradford); Vice-Presidents, Mr. H. Sayers (Leeds) and Mr. A. S. Worcester (Huddersfield); Hon. Secretary, Mr. S. W. Wise (Bradford); Council, Messrs. J. W. Blair (York), J. Butterworth (Halifax), W. Hird (Bingley), O. H. Wass (Leeds), J. J. Watson (Huddersfield), R. D. Welford (Bradford), H. Forrest (Bradford), S. Wise, junr. (Bradford), and G. Booth (Bradford); Delegate to the General Council, Mr. Worcester; Auditors, Messrs. Welford and Hird.

The President referred to the proposed Summer Outing of the Branch to Newcastle and the North-East Coast Exhibition, and said up to the present the necessary arrangements had not been completed, but as soon as they were the Secretary would notify each member of the details.

STANTON
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IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

A tablet to the memory of Matthew Murray, "The Father of Leeds Engineering," was unveiled at Leeds recently.

According to a French paper, the Union of South Africa has placed an order for rails in France, the contract sum being £250,000.

The Quipcast Company has changed its address from 21, Wardour Street, London, W.1, to 119, Moorgate (Room 104), London, E.C.2. The 'phone number is : London Wall 3939.

The sports ground of the "Keith-Blackman" Athletic Club, of J. Keith & Blackman Company, Limited, was recently opened by the director and general manager, Mr. J. W. Hampsheir.

Ardrossan Shipyard Company's employees have contributed £240 to various charitable institutions. The yard's sickness fund has also paid 260 sick claims and 1,200 cash payments during the year.

Messrs. John Lewis & Sons, Limited, Aberdeen, have launched "The Loch Carron," which is the largest trawler ever built in that city for local owners, for the Loch Line Trawling & Fishing Company, Limited.

It is reported that Messrs. Andrew Weir & Company, Limited, Glasgow, have ordered two more motorships for the Bank Line from Messrs. Harland & Wolff, Limited, Belfast. The vessels will be fitted with Harland-B. & W. internal-combustion engines.

The partnership between Messrs. D. R. Plews and H. W. Plews, carrying on business as engineers and ironfounders, at Bridgefield Ironworks, Elland, Yorks, under the style of Plews & Turner, has been dissolved. Mr. H. W. Plews will continue the business.

Messrs. Alexander Hall & Company, Limited, Aberdeen, have just launched two dual purpose boats of the type known as the drifter-trawler, for Messrs. Bloomfields, Limited, Great Yarmouth, an associate company of the Mac Fisheries. The machinery, consisting of triple expansion engines, has been supplied by the builders.

Members of the Coventry Engineering Society paid a visit to the Imperial Steelworks of Messrs. Edgar Allen & Company, Limited, at Tinsley, Sheffield, recently. The working of Stag Major high-speed steel was demonstrated, and the visitors also inspected the steel foundries, forging press, heat-treatment plant, high-frequency furnaces, and steel warehouses.

The Clyde Shipbuilding and Engineering Yard, Port Glasgow, which recently went into liquidation, has been purchased by Messrs. J. Lamont & Company, Limited, ship repairers, Greenock. The shipyard, slips and engineering shops are included in the deal, but not the foundry. Messrs. Lamont intend to use the yard as an extension of their ship repairing establishment.

A start has been made with the dismantling of Ward Foundry, Dundee, one of the oldest works of the kind on the East Coast of Scotland. The foundry was started over a hundred years ago by the famous engineers, James and Charles Carmichael, the former having been an inventor of world-wide fame. The foundry was closed recently, and a Glasgow firm is now engaged in removing equipment.

The Board of Trade have referred to the Standing Committee under the Merchandise Marks Act, 1926, an application for an Order in Council requiring the marking, with an indication of origin, of bolts, nuts and studs of iron and steel. The Committee will consider whether these articles should be marked on sale or exposure for sale, and they may, at their discretion, also consider whether the articles should be marked on importation. The date of the Committee's public inquiry will be announced later.

Several changes have taken place at Rolls-Royce, Limited, Derby, following the resignation of Mr. Basil Johnstone, the managing director of the firm. Mr. A. F. Sidgreaves, the general manager, will take Mr. Johnstone's position, and Mr. A. Wormald, the works manager, has also been elected a director. Mr. W. M. Cowen has been promoted from general manager at London to general manager of the company, and Major Cox, who has been with the company for 24 years, is the new sales manager.

Negotiations which have been carried on during the past two years between Dr. Robert J. Anderson and the Soviet Government relative to the construction of an aluminium-reduction works in Russia have come to an end. The parties to the negotiations were unable to agree to terms and details of carrying out the project. Plans called for the design and erection of a works to produce about 10,000 tons of aluminium per annum, together with an alumina plant and carbon-electrode factory.

Messrs. William Beardmore & Company, Limited, Parkhead, Glasgow, have received an order to construct 32 locomotives for the Indian State Railways. The contract is a valuable one, as the cost of each engine is about £8,000. The boilers will be constructed at Parkhead and the other work at Dalmuir. Messrs. Beardmore have on hand an order for 44 locomotives for the Indian State Railways, and although the number of employees may not be increased a welcome continuation of work is assured.

Messrs. John A. Smeeton, Limited, engineers, of 15, Victoria Street, London, S.W.1, have been appointed sole British agents by the Badische Maschinenfabrik und Eisengiesserei, of Durlach and Karlsruhe, who are the well-known designers and manufacturers of all classes of foundry machinery and plant. They have taken a large stand at the forthcoming International Foundry Trades Exhibition, to be held next month in London, where they will be showing and demonstrating a considerable number of their latest machines.

A launch of unusual interest took place at Govan recently. The vessel was the sea-going motor yacht "Seahawk," built by the Rigidius Boat Company, Limited, of Whiteinch, in the repairing yard of Messrs. Barclay, Curle & Company, Limited, to the order of Mr. F. W. Fell Clark, of Glen Caladh, Tighnabruich. The propelling machinery consists of twin engines supplied by Gleniffer Motors, Limited, Glasgow. The vessel was not launched in the ordinary way. She was conveyed from the works on a bogie to Princes Dock and then lowered by the Clyde Trustee's large fitting out crane.

Messrs. Henry Robb, Limited, Leith, have launched a caisson, which they designed and constructed for the Prince of Wales graving dock of Leith Dock Commissioners. The caisson, which is 76 ft. in length and 29 ft. in depth, is divided into seven water-tight compartments, four of which are ballast tanks. A pump of the single-suction, vertical-spindle, centrifugal type, capable of delivering 375 tons of water per hour, is fitted in a large pump room, and the motor is arranged to work by electric current taken from the Commissioner's shore mains. The upper deck of the caisson will form a roadway across the mouth of the dock.

The steel industry of Lanarkshire is showing a revival. For some years, and particularly since 1926, the entire steel area of Lanarkshire has been depressed, but with the exception of Messrs. William Beardmore & Company, Limited, Mossend Steel Works, which have been completely idle since the scheme to reduce costs came into force, all the rest of the big works are showing improvement. At Messrs. Stewarts & Lloyds, Clydesdale works, Mossend, and Messrs. David Colville & Sons, Dalzell works, the largest of the works in the district, work has been increasing daily. A sign of the briskness is indicated at Flemington, where the Lanarkshire Steel Company has just put a new steel-melting furnace into operation. It is stated that this furnace will produce something like 750 tons of steel per week. Quite recently the old side furnaces at Messrs. David Colville's Clydebridge works were ordered to be prepared for operation.

Personal.

Mr. J. Beaumont Nielson, deputy chairman of Messrs. Baldwins, Limited, has joined the board of the English Steel Corporation, Limited.

Mr. N. G. Barraclough has been appointed to the post of chief engineer of the Workington Iron and Steel Branch of the United Steel Companies, Limited.

Mr. Robert Mason has been appointed, by the Governor in Council of the South Australian Government, to be an Honorary Commissioner to inquire into and report upon the modern foundry practice and plant, and the making of special alloys in Great Britain, the Dominion of Canada, and the United States of America.

On the occasion of his leaving to take up an appointment in Ceylon, Mr. James Forbes, Junr., who has been in the employ of the Shotts Iron Company for some years, was made the recipient of parting gifts from the staff at a social gathering. The meeting was presided over by Mr. A. B. Allison, blast-furnace manager, and the presentation made by Mr. George Smith, cashier.

Mr. L. D. Whitehead, of the Whitehead Iron & Steel Company, Limited, Tredegar and Newport, Mon., has been presented by the workmen and staff of the company with an oil portrait of himself as high-sheriff of Monmouthshire. The presentation marked triple events of last year, which was the twenty-fifth year of the existence of the firm, the year of Mr. Whitehead's silver wedding, and his year of office as high-sheriff.

Mr. W. A. Machin, of Corporation Street, Birmingham, has been appointed by the Tredegar Iron and Coal Company, Limited, to be agent for the sale of their steel arches in the counties of Shropshire, Warwickshire, Leicestershire, Staffordshire and Derbyshire south of the town of Derby. Mr. Machin has also been appointed sole Midland agent for the Rotary Air Compressor Company, Limited, London, and sole agent for Richard Sutcliffe, Horbury, Wakefield, for belt conveyors for the counties of Warwick, Stafford, Salop, Somerset, the Forest of Dean, and also South Wales.

Wills.

Hay, G. M., Strathclyde Foundry, Bridgeton, Glasgow	£71,949
Foster, T. E., of Old Trafford, late managing-director of Morrison, Ingram & Company, Limited, of Hygeia Works, Hadfield Street, Carnbrook, Manchester, brass- and iron-founders	£6,223
Spear, F. G., of F. G. Spear, Limited, 58, Stanhope Street, Birmingham, brass-founders	£6,803

Obituary.

Mr. Walter Cathcart, a brass moulder in a Paisley foundry, has died at his home, Underwood Road, Paisley, at the age of 71.

Mr. John Gibson died suddenly on board a P. & O. liner near Colombo while on his way home to Falkirk. He was the oldest (twin) son of the late Mr. John Edward Gibson, ironfounder, Falkirk (Walker Hunter & Company Limited).

Mr. J. C. Blair, a director of Messrs. A. G. Kidston & Company, Limited, iron and steel merchants and exporters, of London and Glasgow, died on Wednesday, May 15, in London. Mr. Blair had been connected with Messrs. Kidston & Company for 45 years, and his genial disposition won him friends in all parts of the world. Starting with the firm in Glasgow when he was 19 years of age, Mr. Blair went to London to start an office in the City in December, 1897. In addition to Mr. Blair's association with Messrs. A. G. Kidston & Company, Limited, he was one of the founders of the London Iron and Steel Exchange.

We regret to announce the recent death of Mr. T. Walker, the foundry manager of Messrs. C. P. Kinnell & Company, Limited, Thornaby-on-Tees,

The late Mr. T. Walker.

at the age of 53. Mr. Walker, who was apprenticed to the iron trade under his father, spent the early part of his career with Messrs. Leemings, of Bradford, Perkins, Son & Barret, The Forge, Bradford, and for many years was foundry foreman of Messrs. J. Parkinson & Son, of Shipley. Going south, he became foundry manager of several well-known firms, and ultimately joined the staff of Messrs. C. P. Kinnell & Company, Limited. Mr. Walker was popular with all of those who knew him, and undoubtedly the trade has lost one of its best characters.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Owing to the usual holiday custom, the Cleveland iron markets have suspended business during the current week, and, judging by the general conditions now ruling in the trade, and the difficulties of meeting the demand, it seems unlikely whether an early improvement in the position can reasonably be expected. In the meantime ironmasters are no longer selling foundry iron, and business is limited to deliveries under contract and the sale by merchants of small parcels of iron which are still at their disposal. For these there is a strong demand, but merchants are strictly limited as to its destination. In these circumstances prices are advancing. Thus 70s. has been paid for No. 3 Cleveland G.M.B. pig-iron, this representing an advance of 1s. 6d. per ton on the official minimum, and other qualities are quoted in proportion, No. 1 foundry iron being at 72s. 6d., No. 4 foundry 69s., and No. 4 forge iron 68s. 6d. per ton.

Continued activity is still maintained in the market for East-Coast hematite, but, so far, prices remain at the levels previously noted. Moreover, as hematite is now relatively cheaper than foundry iron, it may attract users of the latter quality. However, the quotation of 74s. per ton for mixed numbers is still general, and No. 1 quality stands at 74s. 6d. per ton. On the North-West Coast Bessemer mixed numbers still stand at 74s. per ton at works.

LANCASHIRE.—Business in foundry pig in this area has been practically in abeyance during the current week, and with one exception quotations remain steady as previously noted. Originally the zoning arrangement gave Derbyshire brands a competitive advantage on the Manchester market of 2s. 6d. a ton. The margin, however, has now been reduced to 1s., making current quotations for Derbyshire and Staffordshire makes 71s. and 72s. per ton respectively, for delivery to local consumers.

THE MIDLANDS.—A temporary lull has been experienced in the local markets for foundry pig, buyers restricting commitments mostly to prompt transactions sufficient to cover immediate requirements. Prices are unaltered, the zone figures being 72s. 6d. for Derbyshire No. 3, 73s. 6d. for Staffordshire No. 3, and 69s. for Northants No. 3, delivered to local stations.

SCOTLAND.—There is no improvement to report in the condition of the Scotch pig-iron trade. Deliveries are fairly steady against existing contracts, but new business is scarce and, generally speaking, only for small tonnages. There is no alteration in the price, which is firm on the basis of 72s. 6d. for No. 3 foundry f.o.t. furnaces.

Finished Iron.

Prices of the various grades of finished iron have not been altered to any further extent, and crown iron remains at from £9 10s. to £10 delivered to consumers' works in the Black Country area. Marked bars are at £12 at makers' works, and nut-and-bolt iron at from £9 to £9 5s. per ton. There continues to be a fair request for Staffordshire marked bars, and the recent improvement noticeable in connection with crown iron is maintained, although there is room for still further expansion, as the mills making this class of iron are not fully engaged. There is little business developing for locally-produced nut-and-bolt iron owing to the competition from the Continent.

Steel.

At Sheffield the steel market is on the quiet side, with the demand for basic billets still the most prominent feature. Some surprise has been caused by an increase of at least ten shillings a ton on acid billets. The control, which was suspended some time ago, has been restored, and the Billet Association has raised the quotation from £8 15s. to £9 to £9 10s. Generally speaking, the demand from structural engineering shops has improved recently, while the requirements of the foundries also appear to be expanding. Transactions in tinplates have been reported at 18s. 3d., but several lines were fixed up on a basis of 18s. 6d., and the general tone of the market may be called a shade better.

Scrap.

Demand for foundry scrap material of late has been gradually increasing, and on the North-East Coast a slight improvement in the consumption of heavy cast iron has been sufficient to advance the price of ordinary quality from 62s. 6d. to 65s., whilst machinery scrap, obtainable previously at 66s., is now up to 67s. 6d. per ton. In the Midlands the demand for heavy cast-iron scrap has been well maintained, 72s. 6d. delivered being offered for machinery scrap in cupola sizes and 60s. delivered for light cast-iron scrap. In Scotland the market for cast-iron scrap is quieter, and it is difficult to obtain many outlets for first-class machinery quality, even at around 73s. 6d. Ordinary heavy cast-iron scrap is at 67s. 6d., old cast-iron railway chairs 68s. 6d. to 70s., and light cast-iron scrap 66s. 3d. to 67s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Following the recent period of inflation, there has been renewed weakness in the copper market, and as a result the immediate outlook is for the moment rather obscure. The recent upward movement, however, was chiefly of an artificial nature, and was the outcome of a squeeze which was accelerated by the depletion of warehouse stocks. Any definite forecast is bound to contain an element of conjecture to a greater or less degree, but indications would point to the fact that the times are not yet propitious for the development of new buying interest.

Closing quotations are :—

Cash.—Thursday, £74 to £74 5s.; Friday, £76 5s. to £76 10s.; Tuesday, £75 2s. 6d. to £75 5s.; Wednesday, £74 to £74 5s.

Three Months. — Thursday, £72 15s. to £72 17s. 6d.; Friday, £73 17s. 6d. to £74; Tuesday, £73 to £73 5s.; Wednesday, £72 15s. to £73.

Tin.—Values of standard cash tin are again recorded below the £200 per ton level. More active buying, however, has been noted of late by consumers of English tin, of which there is still a large surplus held. The outlook at the moment is by no means clear, but, taking into account the resistance which is encountered at around the current levels, any further serious decline does not appear likely.

Official closing prices :—

Cash.—Thursday, £198 5s. to £198 7s. 6d.; Friday, £196 10s. to £196 15s.; Tuesday, £196 to £196 5s.; Wednesday, £196 15s. to £197.

Three Months.—Thursday, £201 to £201 2s. 6d.; Friday, £199 12s. 6d. to £199 15s.; Tuesday, £198 17s. 6d. to £199 2s. 6d.; Wednesday, £199 5s. to £199 7s. 6d.

Spelter.—The course of the spelter market has been rather erratic of late, and business has not been very active, while dealers have shown a reluctance to enter into further commitments. Supplies during the past month have been ample to meet all requirements, although production should be fairly well in line with the consumption as a result of the operation of the European Zinc Cartel.

Daily quotations are :—

Ordinary. — Thursday, £26 13s. 9d.; Friday, £26 16s. 3d.; Tuesday, £26 16s. 3d.; Wednesday, £26 16s. 3d.

Lead.—As a result of the tendency of consumers in this country to wait till after the approaching General Election before covering their requirements, the market for foreign pig has been disappointing.

Prices have been :—

Soft Foreign Prompt.—Thursday, £23 16s. 3d.; Friday, £23 17s. 6d.; Tuesday, £23 15s.; Wednesday, £23 13s. 9d.

Students' Corner

Q.—If the core were under-baked, what would be the result?

A.—In that case, the baked part of the core would draw the oil towards it, and if allowed to stand for any length of time, would become saturated again, and would produce blown castings, also there would be a danger of the core breaking, or being deformed.

Q.—Are good drying conditions the same for clay-bonded cores, as with oil-sand-cores?

A.—So far as temperature is concerned, there is not much difference, i.e., with medium-sized cores. The difference when drying is : With naturally-bonded cores, it is chiefly the evaporation of moisture, with oil-sand-cores after the evaporation of moisture follows partial oxidation of the artificial bond.

Q.—Should oil-sand-cores be blackwashed with a plumbago-blacking, or left untouched?

A.—Oil-sand-cores in many cases may be used without being blacked, and the casting will show a good skin. The reason for this is—that the residue from the oil behaves something after the manner of coal dust in green-sand facings, when being cast it evolves a tarry matter and gases. These bodies break up under intense heat of the liquid metal and deposit a soot (a form of carbon), which acts as a lubricant for the flow of the metal on the core-face and also as a refractory material, preventing the burning-on of the sand to the metal. The advantage of blacking the cores would be to give a smoother skin when coarse silica sands are used, also it would be an advantage as a precautionary measure when the cores are surrounded by thick bodies of metal in iron, or steel castings.

Q.—Is there any guide as to when an oil-sand-core is sufficiently dried?

A.—This matter is of the highest importance, as it often involves the success, or failure, of oil-sand-cores. Experience is the best guide, as it depends largely upon the kind of binder used ; but from experiments made with cores having a binder with a linseed oil base, it has been shown so far as strength and colour of core is concerned, that some guide may be obtained. The following (quoted from Poole) shows that an under-baked, sufficiently-baked, and over-baked cores differ in strength and colour.

Colour and Tensile Tests on an Inch-square Core.

Average of 12 Cores.

Time of baking	**23 min.**	**38 min.**	**60 min.**
Temperature	**240° C.**	**240° C.**	**240° C.**
Tensile test	**55 lbs.**	**111 lbs.**	**79 lbs.**
Colour	**Light brown.**	**Nut brown.**	**Dark brown.**

Compression Test, 2½-in. Cube.

Time of baking	**60 min.**	**75 min.**	**90 min.**
Temperature	**240° C.**	**240° C.**	**240° C.**
Compression	**0.66 ton**	**1.10 tons**	**0.86 ton**
Colour	**Light brown.**	**Nut brown.**	**Dark brown.**

It is announced that the present partners in the firm of Catto, Mather & Company, iron, steel and machinery merchants, of Liverpool and London, namely, Messrs. J. K. Catto, F. S. Vosper and R. H. Catto, have decided to retire from the business altogether as from May 31 next. After that date the business will be continued under the style of Catto, Mather & Company, Limited, at 1, Lloyds Avenue, London, E.C.3, and at 112, The Albany, Liverpool. The management will be in the hands of Mr. Wm. Austin.

The Great Yarmouth Iron Works and Foundry Company, Limited, is being wound up voluntarily. Mr. S. T. Tunbridge, 6, South Quay, Great Yarmouth, is the liquidator.

The first annual statement and balance-sheet of the Australian Iron and Steel Company, Limited, shows a profit of £182,000. Operations cover the Lithgow steelworks and collieries and the Sydney and Brisbane pipe works for twelve months, the Sydney and Melbourne steel fabricating works for eight months and the Port Kembla blast furnace for three months. An interim dividend on the 7½ per cent. preference shares was paid in November, leaving a balance of £155,000 to be carried forward.

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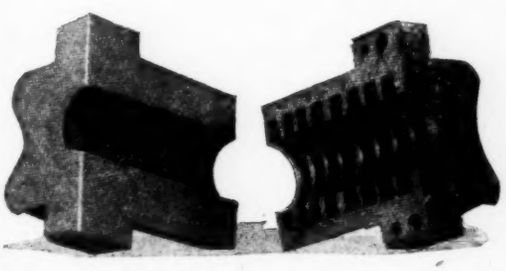
6. THICK SECTION CASTINGS

	PLAIN IRON.	NICKEL IRON.
TOTAL CARBON ..	3.3	3.3
SILICON	1.2	1.0
NICKEL	Nil	1.25

Castings of thick section which must not show porosity in the body of the casting on machining.

PLAIN IRON.	NICKEL IRON.
Porous and unsound patches in the middle of the Section on machining.	Uniformly dense, fine grained structure throughout theSection. Casting uniformly machinable.



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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	74	0	0
Three months	72	15	0
Electrolytic	84	0	0
Tough	75	0	0
Best selected	75	10	0
Sheets	112	0	0
India	98	0	0
Wire bars	84	12	6
Do. June	84	12	6
Do. July	84	12	6
Ingot bars	84	12	6
H.C. wire rods	86	15	0
Off. av. cash, April	81	2	7 1/4
Do. 3 mths., April	78	19	8 3/4
Do., Sttlmnt., April	81	2	8 3/4
Do., Electro, April	90	17	11 3/4
Do., B.S., April	85	16	11 1/2
Aver. spot price, copper, Apl.	81	2	7 1/16
Do. wire bars, April	92	7	10 3/4
Solid drawn tubes			15 1/2d.
Brazed tubes			15 1/2d.
Wire			12 1/2d.

BRASS.

Solid drawn tubes	13d.
Brazed tubes	15d.
Rods, drawn	12 1/2d.
Rods, extd. or rlld.	8 1/2d.
Sheets to 10 w.g.	11 3/4d.
Wire	11 1/2d.
Rolled metal	10 3/4d.
Yellow metal rods	8 1/2d.
Do. 4 × 4 Squares	9d.
Do. 4 × 3 Sheets	9 1/2d.

TIN.

	£	s.	d.
Standard cash	196	15	0
Three months	199	5	0
English	198	0	0
Bars	199	5	0
Straits	197	10	0
Australian	198	0	0
Eastern	202	5	0
Banca	201	0	0
Off. av. cash, April	206	19	7 1/2
Do., 3 mths., April	208	1	5 1/2
Do., Sttlmt., April	207	0	0
Aver. spot, April	206	19	7 1/2

SPELTER.

	£	s.	d.
Ordinary	26	16	3
Remelted	25	10	0
Hard	21	10	0
Electro 99.9	30	0	0
English	27	2	6
India	23	15	0
Zinc dust (Nom.)	36	10	0
Zinc ashes	9	0	0
Off. aver., April	26	13	8 7/16
Aver., spot, April	26	15	2 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	23	13	9
English	25	0	0
Off. average, April	24	11	10 1/2
Average spot, April	24	15	7 1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	35	0	0
Do. V.M. ex whf.	33	7	6
Rods	42	0	0
Boiler plates	31	0	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	50	15	0
Chinese	35	0	0
Crude	Nominal		

QUICKSILVER.

	£	s.	d.
Quicksilver	22	3	9

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	7 17 6
45/50%	12 0 0
75%	19 5 0
Ferro-vanadium—	
35/50%	..13/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	..4/- lb. Mo.
Ferro-titanium—	
23/25% carbonless	11d. lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	2/9 lb.
Tungsten metal powder—	
98/99%	2/11 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£24 5 0
6/8% car.	£23 2 6
8/10% car.	£22 17 6
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£37 12 6
Max. 0·70% car.	£41 12 6
70%, carbonless	1/2 lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/4 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/6 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finshed bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/4 in. to 1/2 in.	3d. lb.
Do., under 1/2 in. to 3/16 in.	1/- lb.
Flats, 1/4 in. × 1/2 in. to under 1 in. × 3/4 in.	3d. lb.
Do., under 1/2 in. × 1/2 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length, 10% extra	

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	17	6	to	3	18	6
Bundled steel and shrngs	3	12	6	to	3	17	6
Mixed iron and steel					3	12	6
Heavy cast iron					3	5	0
Good machinery for foundries					3	10	0
Cleveland—							
Heavy steel					3	5	0
Steel turnings					2	18	6
Cast iron borings					2	15	0
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	5	0	to	3	7	6
Lancashire—							
Cast-iron scrap	3	0	0	to	3	10	0
Hvy. wrought					3	15	0
Steel turnings					2	17	6
Scotland—							
Heavy steel					3	15	0
Cast-iron borings					2	15	0
Wrought-iron piling					3	12	6
Heavy machinery					3	13	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	62	0	0
Brass	40	0	0
Lead (less usual draft)	21	5	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	67	0	0
Braziery copper	53	0	0
Gunmetal	52	0	0
Hollow pewter	160	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	72/6
Foundry No. 3	70/-
Foundry No. 4	69/-
Forge No. 4	68/6
Hematite No. 1	74/6
Hematite M/Nos.	74/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
„ d/d Birm.	90/-
Midlands—	
Staffs. common*	—
„ No. 4 forge*	69/6
„ No. 3 fdry*	73/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	65/-
„ fdry. No. 3*	69/-
Derbyshire forge*	68/6
„ fdry. No. 3*	72/6
„ basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	75/-
„ No. 3	72/6
Hem. M/Nos.	78/-
Sheffield (d/d district)—	
Derby forge	63/6
„ fdry. No. 3	67/6
Lincs. forge	68/6
„ fdry. No. 3	72/6
E.C. hematite	85/-
W.C. hematite	87/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	71/-
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	90/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	90/-
Monkland, No. 3	90/-
Shotts, No. 3	90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops					11	10	0
Marked bars (Staffs.) f.o.t.					12	0	0
Gas strip					11	10	0
Bolts and nuts, 3/4 in. × 4 in.					15	5	0
Steel—							
Ship plates	8	12	6	to	8	17	6
Boiler plts.					10	10	0
Chequer plts.					10	12	6
Angles					8	2	6
Tees					9	2	6
Joists					8	2	6
Rounds and squares, 3 in. to 5 1/2 in.					8	17	6
Rounds under 3 in. to 3/8 in. (Untested)					8	0	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1 1/2 in.					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs.)					10	10	0
Black sheets, 24g.					10	10	0
Galv.cor.shts., 24g.	13	7	6	to	13	15	0
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	7	6	to	7	0	0
Billets hard	7	10	0	to	8	2	6
Sheet bars	6	5	0	to	6	10	0
Tin bars	6	5	0	to	6	10	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6 1/2
Rods	1/5
Tubes	1/9
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4 1/2 to 1/10 1/2
To 15 in. wide	1/4 1/2 to 1/10 1/2
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5 1/2 to 1/11 1/2
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6 1/2
Ingots rolled to spoon size	1/1 to 1/9 1/2
Wire round—	
3/0 to 10 G.	1/7 1/2 to 2/2 1/2

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	15.00
Basic	19.76
Bessemer	20.76
Malleable	20.76
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	36.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 30/-
„ furnace	22/- to 25/-
Durham and North.	
„ foundry	16/-
„ furnace	16/6
Midlands, foundry	—
„ furnace	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box		18/6
„	28×20 „		36/6
„	20×10 „		26/3
„	18 1/2×14 „		18/9
C.W.	20×14 „		15/3
„	28×20 „		33/6
„	20×10 „		21/3
„	18 1/2×14 „		16/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

Electrolytic Copper.

			£	s.	d.		
May	16	..	83	0	0	No change	
,,	17	..	83	12	6	inc.	12/6
,,	21	..	83	12	6	No change	
,,	22	..	84	0	0	inc.	7/6

Tin (English ingots).

			£	s.	d.		
May	16	..	199	10	0	dec.	5/-
,,	17	..	198	0	0	,,	30/-
,,	21	..	197	5	0	,,	15/-
,,	22	..	198	0	0	inc.	15/-

Spelter (ordinary).

			£	s.	d.		
May	16	..	26	13	9	No change	
,,	17	..	26	16	3	inc.	2/6
,,	21	..	26	16	3	No change	
,,	22	..	26	16	3	,,	,,

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.		
May	16	..	74	0	0	inc.	32/6
,,	17	..	76	5	0	,,	45/-
,,	21	..	75	2	6	dec.	22/6
,,	22	..	74	0	0	,,	22/6

Standard Tin (cash).

			£	s.	d.		
May	16	..	198	5	0	dec.	15/-
,,	17	..	196	10	0	,,	35/-
,,	21	..	196	0	0	,,	10/-
,,	22	..	196	15	0	inc.	15/-

Zinc Sheets (English).

			£	s.	d.		
May	16	..	35	0	0	No change	
,,	17	..	35	0	0	,,	,,
,,	21	..	35	0	0	,,	,,
,,	22	..	35	0	0	,,	,,

Lead (English).

			£	s.	d.		
May	16	..	25	5	0	No change	
,,	17	..	25	5	0	,,	,,
,,	21	..	25	5	0	,,	,,
,,	22	..	25	0	0	dec.	5/-

AVERAGE PRICES OF STEEL RAILS.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	6 2 6	6 0 0	6 0 0	5 15 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 16 3
1909	5 5 0	5 5 0	5 5 0	5 0 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0
1910	5 5 0	5 7 6	5 7 6	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 8 11½
1911	5 15 0	5 15 0	5 15 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 13 1½
1912	5 13 1	5 15 0	5 15 0	5 15 7	6 1 6	6 6 3	6 7 6	6 8 0	6 11 3	6 12 6	6 12 6	6 13 9	6 4 4
1913	6 15 0	6 14 4½	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	6 12 0
1914	6 10 0	6 10 0	6 6 3	6 0 0	6 0 0	6 0 0	5 14 0	6 2 6	6 13 9	6 12 0	6 7 6	6 7 6	6 5 3½
1915	6 10 6	6 17 6	7 5 0	7 12 6	7 12 6	7 17 6	8 17 6	9 2 6	9 2 6	9 2 6	9 7 6	10 10 6	8 6 6½
1916	10 19 4	11 0 0	11 0 0	10 18 9	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 9 10
1917	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1918	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	—	—	—	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	83 11	88 6	94 8	107 0	102 6	101 3	98 9	98 7½	96 6	104 0	124 1	130 0	106 11½
1916	133 9	140 0	136 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	128 1½
1917	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY FOREMAN desires position; experienced all branches engineering and jobbing work, iron and non-ferrous; knowledge of metallurgy and mixing of metals by analysis; good organiser; can get maximum production and consistent results.—Box 216, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ENERGETIC YOUNG SCOTSMAN, thorough knowledge Light Castings trade, drawing office and works experience, 3½ years' representation of a leading Scottish foundry, resident London, desires post with first-class English foundry; excellent references.—Box 224, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Foundry Foreman with good experience in Machine Moulding; must be thoroughly up to date and have sound references as to organising ability and piece-rate fixing; also fully experienced in Cupola practice and mixture of metals.—Reply, giving all necessary particulars, to Box 226, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, a first-class Estimating Clerk for modern foundry, thoroughly used to extending weights from blue-prints.—Apply, stating age, wages required, also references.—Box 228, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—KING'S PATENT AGENCY, LIMITED, 146A, Queen Victoria Street, E.C.4.

AUCTIONS.

MYTHOLMROYD, NEAR HALIFAX.

In re RUPERT H. PICKLES, LIMITED, Iron Founders, Boiler and Radiator Makers.

CHARLES WM. LAYCOCK will OFFER FOR SALE BY AUCTION, at the EMPRESS FOUNDRY, MYTHOLMROYD, on TUESDAY, MAY 28, 1929, at 10.30 a.m. prompt:—

LOT 1.—The Important and Extensive WORKS PREMISES, known as the EMPRESS FOUNDRY, situate at MYTHOLMROYD, adjoining Burnley Road, within a few minutes of the L.M.S. Railway and having an extensive frontage to the Rochdale Canal. Modern Stone-built Foundry, 464 ft. long x 57 ft. wide inside measurement, with Power-House, Latrines, Store Rooms, etc.; Stone-built Engineer's Workshop measuring 80 ft. x 39 ft.; Handsome Stone-built Suite of Offices; Extensive Yard and Vacant Land containing 5,750 sq. yds. or thereabouts.

Lot 1 is Leasehold for the residue of terms of 999 years and 995 years.

LOT 2.—The Substantially Stone-built MECHANIC'S SHOP adjoining Lot 1, 65 ft. x 34 ft. inside measurement, used as Radiator Works, containing 495 sq. yds. or thereabouts.

Lot 2 is Leasehold for 999 years.

LOT 3.—The Valuable PLOT OF FREEHOLD BUILDING LAND in West End Terrace, Mytholmroyd, containing 1,600 sq. yds. or thereabouts, forming site of new building, 170 ft. x 60 ft. Lots 1, 2 and 3 will first be offered together as a whole. Printed particulars may be obtained from the AUCTIONEER, 11, George Street, Halifax (where plans may be inspected); MESSRS. SUTCLIFFE & RHODES, Chartered Accountants, Fountain Chambers, Halifax; or from the undersigned, at whose offices the Special Conditions of Sale may be inspected three days prior to Sale.

FREDERICK WALKER & SON, Solicitors,
2, Harrison Road, Halifax.

AUCTIONS—*Continued.*

MYTHOLMROYD, NEAR HALIFAX.

In re RUPERT H. PICKLES, LIMITED, Empress Foundry, Ironfounders, Boiler and Radiator Makers.

CHARLES WM. LAYCOCK, instructed by Horace Rhodes, Esq., Chartered Accountant, Receiver for the Debenture Holders, will SELL BY AUCTION on the above PREMISES, on TUESDAY and WEDNESDAY, MAY 28 and 29, 1929:—

THE MODERN FOUNDRY AND ENGINEERING FIXED AND LOOSE PLANT AND MACHINERY, RADIATOR AND BOILER PATTERNS AND PARTS, AND ENTIRE CONTENTS OF WORKS.

Nearly new 45-h.p. Campbell Cold-starting Heavy Oil Engine; B.W. D.C. Generator, 36 kw., 475 volts; 12 Electric D.C. Motors; 4 Electric Overhead Travelling Cranes, 3 to 7½ tons, 27-ft. to 56-ft. span; 7- and 5-ton Cupolas with 2 K.B. Electric Fans; 2 Ingersoll Rand Air Compressors, Class E.R.1; 7 Pneumatic Jolt Machines, from 3-in. to 20-in. cylinders, 3-cwt. to 7-ton capacity; 15 Pneumatic and Radiator Moulding Machines; Sand-Mixing Machine; 3 Rattle Boxes; Grinding Machines; Electric Sand-Riddling Machine; Pig-iron Breaker; Geared Crane Ladles; Rotary Core-making Machine, 2½ in. dia.; 8 Jib Cranes; the Vaughan Overhead Runway System; Vaughan Runway Carriages; Chain Blocks; Railway Trucks; Bogeys; Girders; 4 Radiator and Boiler Testing Machines; about 150 Tons Moulding-Boxes; 100 Tons Tested Radiator and Boiler Section Castings for Premier Radiators and Paragon Boilers; about 50 Tons Radiator Section Core Boxes; Jigs and Wood Patterns for Paragon Boiler P1 to P4.

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